Before the
FEDERAL COMMUNICATIONS COMMISSION
Washington, DC 20554

Unlicensed National Information	)	ET Docket No 13-49
Infrastructure (U–NII) Devices	)	
in the 5 GHz Band	)	FCC 16-68

COMMENTS OF THE

CAR 2 CAR COMMUNICATIONS CONSORTIUM

I. INTRODUCTION

The CAR 2 CAR Communication Consortium (C2C-CC) is a nonprofit, industry driven organization initiated by European vehicle manufacturers and supported by equipment suppliers, research organizations and other partners. The C2C-CC was founded in 2002 by vehicle manufacturers promoting the idea of cooperative road traffic with Vehicle-to-Vehicle Communications (V2V) supported by Vehicle-to-Infrastructure Communications (V2I). Today, the Consortium comprises eighty (86) members, with sixteen (17) vehicle manufacturers, thirty-six (39) equipment suppliers and twenty-eight (30) research organizations.

Over the years, the C2C-CC has evolved to be one of the key players in preparing the initial deployment of Cooperative Intelligent Transport Systems (C-ITS) in Europe and the subsequent innovation phases. C2C-CC members focus on wireless V2V communication applications based on ETSI ITS-G5 / IEEE 802.11p[1] and concentrate all efforts on creating standards to ensure the interoperability of cooperative systems, spanning all vehicle classes across borders and brands. As a key contributor, the C2C-CC works in close cooperation with the European and international standardization organizations such as ETSI and CEN.

One of the key missions of the C2C-CC is to promote the harmonization of V2V communication standards worldwide. As we remain only in the early stages of deploying V2V communications technology, industry and government have a unique opportunity and duty to establish harmonized rules and regulations. Failure to enact harmonized requirements will lead to delays, lost safety benefits, and needless expenditure of resources. In Europe, it has already been determined that reallocation of ITS channels is not an option. This being the case, re-channelization approaches (if adopted in the U.S.) would be a major setback for harmonization. In

[1] ETSI ITS-G5/IEEE 802.11 p is comparable to DSRC / Wave in the U.S. Both are based on IEEE 802.11p.

the view of the C2C-CC, sharing approaches that cannot be implemented outside the U.S. (e.g., re-channelization) should be avoided.

For safety-of-life systems to function properly, the C2C-CC believes that a minimum bandwidth of 50 MHz will be required. [14] Today, spectrum is already required for applications like truck platooning and cooperative Adaptive Cruise Control (C-ACC). Dedicated DSRC spectrum necessary to accommodate many future safety applications (including those for pedestrians) must be made available and free of interference.

II. RESPONSES TO SELECT QUESTIONS CONTAINED IN THE FCC NOTICE

What are the benefits and drawbacks of each approach?

There are several drawbacks associated with the re-channelization approach. Most notably, the re-channelization approach does not support harmonization with emerging global markets. In Europe (the third largest automotive market in the world), the European Conference of Postal and Telecommunication Administration (CEPT) regulators have clearly stated that reallocation of ITS channels is not an option and the existing channeling arrangement will not be changed. [6] [18]

Channel reallocation to avoid interference between DSRC and 802.11 RLAN (wireless LAN) is not feasible. In Europe, spectrum above the 5925 MHz frequency range is heavily used for high capacity Fixed Services Point to Point links, mainly forming the fixed, mobile and broadcasting infrastructure within the CEPT. In Europe, re-channelization would potentially cause interference in the upper 20 MHz DSRC band. [4] [5]

The established DSRC spectrum framework proposed by the National Highway Traffic and Safety Administration (NHTSA) has been the basis for developing V2V and V2I technology. The introduction of any changes to the DSRC channel plan would negatively impact the U.S. DSRC standardization efforts of SAE and IEEE by rendering the IEEE 1609 architecture obsolete. Re-channelization will lead to a complete restructuring of the DSRC system architecture including the reworking of relevant standards (IEEE 1609.3/.4 and SAE J2945). All devices based on reworked standards would then need to be retested. This and additional compliance testing for new specifications yet to be determined would push back the deployment of available safety-of-life technology for several years.

Would one approach be better than the other (e.g., minimize the risks of interference to DSRC more effectively while providing a comparable degree of meaningful access to spectrum for unlicensed devices)?

Both approaches, Detect An Avoid (DAA) and re-channelization, use a detection mechanism and an avoidance mechanism. The DAA approach could be complimentary to existing technology if implemented without any changes to the DSRC regulation. The DAA strategy supports global harmonization. Using the DAA strategy, harmful interference can be prevented with the RLAN mitigation technique by detecting all seven channels and vacating the entire UNII-4 band if only one DSRC channel communication has been detected.

The re-channelization approach only benefits new RLAN services based on the existing IEEE implementation of RLAN. The main issue is in the application of re-channelization to DSRC systems. Newer RLAN standards (802.11ax) will allow for more flexible spectrum usage that would no longer require availability of the whole 160 MHz spectrum band. New RLAN standards would invalidate certain arguments by proponents in support of the re-channelization approach:

- RLAN proponents have been interested in using the extended 5 GHz band for broadband channels (e.g. 80 MHz and 160 MHz). The extension into the 5.9 GHz would only allow for 1 additional 160 MHz or 1 additional 80 MHz channel.

- The actual IEEE standard 802.11ac only allows continuous channels without the ability to switch off and on separate sub-band/carriers.

- The IEEE 802.11 developments have evolved. One new standard currently being developed in IEEE 802.11ax has several new features that allow for a more flexible and efficient usage of spectrum:
    - Orthogonal Frequency-Division Multiple Access (OFDMA);
    - Advanced spectrum management by flexible channel bonding with no requirements for contiguous spectrum;
    - Ability to dynamically switch on and off the use of DSRC spectrum depending on the deployment within the band;
    - The 160 MHz channel can be reduced to 100 MHz on the detection of DSRC operation.

<u>Further disadvantages of re-channelization include:</u>

- In Europe, a re-channelization approach is in conflict with the position that no additional burden shall be put onto the ITS system.

- Re-channelization will significantly delay introduction of the DSRC system due to a complete restructuring of the system architecture including the relevant standards (IEEE 1609.3/.4 and SAE J2945).

For either approach, is it necessary for the Commission to specify all the details of the interference avoidance mechanism in the FCC rules or can this be addressed by relying primarily on industry standards bodies to develop the specific sharing methods?

Yes, all details of the interference avoidance mechanism need to be specified in the FCC rules. Standards alone will not be sufficient.

What specific technical details need to be specified in the FCC rules (e.g., out-of-band emissions, noise tolerance, detection threshold, channel vacate time, etc.)? Has industry agreed upon performance indicators for DSRC, and if so, what are these metrics and is there a process to hold products to these performance levels?

The FCC regulation should address the following aspects:

- Signal detection in regards to the sensitivity and dynamic conditions of DSRC (i.e. a highly dynamic environment, including (Doppler/multipath) effects from moving sources on the transmitted and received signals).

- The European CEPT Report 57 [6] and ECC Report 244 [8] describe the minimum set of necessary requirements, which should be based upon an appropriate regulation.

- Detect all 7 ITS channels and vacate all ITS channels if DSRC traffic is detected in one channel.

- Parameters and mechanisms involved in DSRC channel congestion control need to be taken in consideration to enable any mitigation approach to ensure that RLAN will not affect channel congestion control mechanisms.

- Parameters to be fixed would include:
    - Maximum reaction time of RLAN.
    - The avoidance parameter needs to be finalized, e.g. avoidance time, residual avoidance power in the DSRC bands, avoidance bandwidth (avoid the complete DSRC band).
    - Vacate time sufficient to protect the DSRC critical scenarios;
    - Sufficient long monitoring time;
    - Initial channel availability check time should be longer than monitoring time;
    - The detection threshold should be better than the minimum DSRC sensitivity supported by current devices;
    - The message error rate shall not increase for safety relevant ranges (hundreds of meters). The message error rate shall not increase significantly for longer ranges.

- Different environmental conditions should be considered (e.g. rural, non-rural, highway).

- Mitigation techniques must support the mobile environment up to the maximum relative speed of vehicles.

- RLAN hot spots which are integrated in vehicles should not be permitted in the 5.9 GHz DSRC band.

- Access point mode for portable devices in the 5.9 GHz DSRC band should not be permitted.

- Direct mode (e.g., Wi-Fi-Direct) for portable devices in the 5.9 GHz DSRC band should not be permitted.

- Robust implementation of mitigation techniques: RLAN software updates related to the DSRC protection mechanisms shall not be possible.

- In order to define the max/min limits of the adequate parameters, test scenarios need to take the following key points into account:
    - Low car traffic density, one DSRC station in radio vicinity/visible to RLAN device
    - A single station (e.g. vehicle 1-10 Hz) safety application message rate. Note: Pedestrians probably will use a much lower message rate than vehicles:
    - A single station moving into an area of high RLAN utilisation reacting with a reduced transmit power;
    - Target performance of maximum lost messages for a low speed DSRC station in 1 hour;
    - Minimum requirement for mitigation technique: It is important to prevent an occurrence of two consecutive messages from the same DSRC source are being interfered;
    - High speed [maximum allowed relative vehicle speed] scenarios are necessary to test the receiver capability of RLAN with Doppler and Multipath capability;
    - Hidden nodes have to be taken into account;
    - Channel congestion control methods [9] (TX power, TX rate control) need to be taken into account, including whether UNI devices will participate in 5.9 GHz DSRC band congestion control;

Would "re-channelization" require any change in the design of the DSRC electronic components contained in DSRC prototypes or just require a change in the processing of the data?

Yes, most DSRC standards need to be updated and changed, by taking into account:

- Redefinition, redesign, re-evaluation, revalidation and qualification of components (depending on the details of the chosen mitigation solution and their impact on the DSRC components).

- Redefinition of new channel allocation.

We seek comment on whether changing the channel plan would require re-testing of DSRC and, if so, precisely what would need to be done, why, and in what timeframe?

- A new channel plan will require a redefinition, redesign, re-evaluation, revalidation and qualification that would take several years to complete. This process can only start when all mitigation elements such as regulation, standardisation and regional harmonization have been established.

- Re-channelization will lead to a complete restructuring of the DSRC system architecture including the reworking of relevant standards (IEEE 1609.3/.4 and SAE J2945). All devices based on reworked standards would then need to be retested.

- The re-channelization approach will limit the RLAN ability to detect DSRC communication in the upper exclusive DSRC bands, which will lead to harmful interference from adjacent channel interference into DSRC. Any negative impact on safety-of-life use cases need to be tested and evaluated. To avoid any negative impact to the upper exclusive DSRC bands, DSRC communication on these bands need to be detected by RLAN.

Should the DSRC offerings provided on a priority or exclusive basis be restricted to safety-of-life or crash avoidance purposes? The definition of safety-of-life applications and the split between the applications should be clarified.

Safety-of-life applications include future automated driving applications such as cooperative ACC, platooning, cooperative perception and intention data, and will protect all traffic participants (pedestrians, bicycles, motorcycles, cars, trucks). This is why safety-of-life applications should receive the highest possible protection and spectrum resources.

Automated driving is a research topic and research will lead to additional spectrum requests [14]

What other spectrum bands, driver-assist technologies, and commercial offerings are providing similar services to those envisioned using DSRC?

DSRC based on IEEE802.11p is the only available ad hoc non-line-of sight communication technology to complement existing in-vehicle sensors (radar, camera, etc.) which is designed to fulfill automated driving functional safety requirements according to ISO 26262 level ASIL A – D. Wide scale deployment of in-vehicle sensors increases, rather than decreases the need for V2V communication. V2V communication provides for the exchange of sensor data, which increases the awareness allowing each traffic participant to improve his own and others safety.

Is it possible that autonomous car and other technologies could bypass DSRC safety-of-life capabilities prior to reaching a sufficient technology penetration to make this service effective?

No, wide scale deployment of advanced driving assistance systems (ADAS) increases the need for V2X communication. ADAS technologies are based on in-vehicle sensors that are enhanced by DSRC by allowing the vehicle to sense hazards around a corner, behind a car or a blind intersection, where the standard sensors (camera, automotive radar) are not able to see. The combination of DSRC and ADAS technologies will facilitate the automotive industry to take one step closer the vision of zero accidents.
Ad hoc communication will be an important component for autonomous vehicles. It will significantly improve the performance and reliability of autonomous system by real time information sharing. Object context information such as dimension, weight, motion status can be shared between vehicles and taken into account in the autonomous driving process. Further, the autonomous vehicles can in near term share their intended trajectories, which today cannot be achieved with traditional sensors such as cameras and radars. DSRC based on IEEE802.11p is the only available ad hoc non-line-of sight communication technology to complement existing in-vehicle sensors, which is designed to fulfill automated driving requirements like:

- Functional safety ability (according to ISO 26262) level ASIL A – D
- Lowest latency for short range communication
- High reliability through BSM broadcast and repetition of messages.
- Ensured channel availability through congestion control mechanisms.

Does the 5.850-5.895 MHz portion of the band potentially offer the most value for unlicensed operations?

The goal of a 160 MHz channel can be achieved without risk to ITS safety applications and without reliance on Dynamic Frequency Selection by e.g. bonding 80 MHz channels in the UNII-1 and 80 MHz channels in UNII-3 bands below existing DSRC bands. Reference the explanation in the previous question regarding IEEE 802.11ax on page 3 and 4.

What are the advantages and disadvantages of combining the non-safety-related channels into larger channels?

The complete band plan and application mapping is based on seven 10 MHz channels. Changes here will significantly influence the overall DSRC systems architecture. In the European regulation and investigations, a channel bandwidth of 10MHz has been assumed. It was found that, at 20 MHz, the guard interval is not long enough and, at 5 MHz, errors increase from lack of channel stationarity over the packet duration. [13]

How should portions of the band not required for safety-of-life applications be shared among DSRC and unlicensed operations?

DAA can be used for non-safety applications like traffic efficiency applications. Beside the safety-of-life applications, the other traffic efficiency applications should have priority over RLAN to enable the public benefits such as CO2 efficiency, pollution reduction, traffic flow optimization, and traffic jam avoidance. We believe that 70 MHz channel capacity for use cases (for traffic safety and traffic efficiency) envisaged in the C2C-CC Roadmap [11], starting with day one use cases and going upwards up to fully automated driving, is absolutely necessary [10] [12].

If commercial or other non-safety DSRC applications have priority access to the band, is a detect-and-vacate protocol necessary or does the IEEE 802.11 standard or other protocols allow for prioritization of DSRC traffic without the need to vacate non-safety channels for a pre-determined time period?

The performance of other mitigation techniques need to be studied in depth before any decisions can be made. The parameter setting will be an important step for all candidate mitigation techniques. A fundamental problem with other techniques that allow packet-by-packet sharing is that DSRC devices will generally not be aware when an unlicensed device is transmitting. In ETSI BRAN, this is known as a unilateral hidden node problem, this could lead to the high probability of packet loss when a DSRC device starts transmitting while an unlicensed device is transmitting. [15]

Would a hybrid approach taking elements from both the "detect and avoid" and the "re-channelization" proposals create benefits for both DSRC and U-NII users?

It is understood that some form of detection is already included in the re-channelization approach. The detection shall be based on 10 MHz channels. The restriction of RLAN usage to the allocated band up to 5895MHz is beneficial as long as no additional restrictions to DSRC are enforced. Out-of-band emissions into the adjacent band need to be restricted in order to minimize the potential influence of these interferences. In addition to the proposed restriction up to 5895 MHz, mitigation techniques in the lower and upper band to protect DSRC communication are needed and should be evaluated.

Are there advantages to an approach where unlicensed users and DSRC non-safety of life applications would share access to the lower 45 megahertz of DSRC spectrum, while unlicensed devices would use a "detect and avoid" approach to avoid, and thus protect, co-channel safety-of-life DSRC operations in the upper 30 megahertz of spectrum?

Thirty MHz for safety-of-life applications is not sufficient. For the applications proposed in the C2C-CC roadmap, 70 MHz of spectrum in 5.9 GHz is needed. The C2C-CC relies on at least 50 MHz spectrum capacity for safety-of-life applications [12]. Note: All the European [17] use cases require protection and prioritization.

Would it be viable to employ an approach based on use of a database to control access to the spectrum similar to that used for the Citizens Broadband Band Radio Service at 3.5 GHz or for White Space devices in the TV and 600 MHz Service bands?

No, since we are talking about fully mobile systems.

Indoor-outdoor discussion: We also invite comment on the ramifications of any of the sharing techniques relative to indoor as well as outdoor use. For instance, is re-channelization, detect and avoid, or a hybrid approach more or less likely to allow for unlicensed indoor and outdoor deployments? Do certain sharing techniques permit more or less indoor or outdoor unlicensed use in certain geographic areas? Are there technical parameters that could be put into place to obviate interference concerns and facilitate deployment of unlicensed networks in either indoor or outdoor environments? For example, would it be feasible to tie the use of lower power levels for indoor-only devices to a less rigorous DSRC

detection method in those devices, leaving the more sensitive DSRC detection methods to higher power outdoor-only units? Is it reasonable to assume that indoor-only devices are less likely to cause interference to DSRC outdoors, thus allowing for less aggressive detection sensitivity? If so, what technical characteristics would be required? We seek a full record on this technique and its specification to assess whether it is possible to share the DSRC band in this manner.

Outdoor usage would be more restricted, though the main issue of indoor and outdoor usage is in the enforcement. Outdoor usage should be regulated with the following proposed conditions:

- RLAN hot spots that are integrated in vehicles shall not be permitted in the 5.9 GHz DSRC band.
- Access point mode for portable devices in the 5.9 GHz DSRC band shall not be permitted.
- Direct mode (e.g., Wi-Fi-Direct) for portable devices in the 5.9 GHz DSRC band shall not be permitted.
- Robust implementation of mitigation techniques: RLAN software updates related to the DSRC protection mechanisms shall not be possible.

III. TIMING

The FCC's proposed timing for testing is not realistic. It calls for prototypes by the end of July 2016 and a three-phase test plan that includes: 1) lab testing, 2) small scale field tests, and 3) large scale field tests. Final conclusions should be drawn and relevant empirical data should be collected out of this testing. Thoroughly testing and validating a mitigation technique is a pre-condition before additional allocation for RLAN usage in 5.9 GHz can be done. DSRC is the primary user of the 5.9 GHz band and the burden to prove that RLAN will not lead to harmful interference, shall lie with the RLAN side. A test plan cannot be completed until the re-channelization approach is fully defined [16].

IV. REFERENCES

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[2] ECC Recommendation (08)01 on the use of the band 5855-5875 MHz for Intelligent Transport Systems (ITS), approved 21 February 2008, amended 3 July 2015.
[3] Commission Decision 2008/671/EC of 5 August 2008 on the harmonised use of radio spectrum in the 5 875-5 905 MHz frequency band for safety-related applications of Intelligent Transport Systems (ITS).
[4] ECC Report 101: "Compatibility studies in the band 5855- 5925 MHz between Intelligent Transport Systems (ITS) and other systems", Bern, February 2007.
[5] ECC Report 228:" Compatibility studies between Intelligent Transport Systems (ITS) in the band 5855-5925 MHz and other systems in adjacent bands ", January 2015.
[6] CEPT Report 57 ('Report A') on the 5 GHz WAS/RLAN extension bands, approved March 2015
[7] February 2004, FCC 03-324, WT Docket No. 01-90, ET Docket No. 98-95 RM-9096 "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 and to the Mobile Service for Dedicated Short Range Communications of Intelligent Transportation Services"
[8] ECC report 244 "Compatibility studies related to RLANs in the 5725-5925 MHz band", approved 29 January 2016
[9] SAE J2945/1, "On-board System Requirements for V2V Safety Communications", Section 6.3.8, Congestion Control, published 2015
[10] Multi Channel Operation, Paul Spaanderman, ETSI TC ITS workshop, March 2016
[11] C2C-CC Roadmap
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[15] ETSI TC BRAN916)000081: challenges in spectrum sharing between ITS-G5 and RLAN
[16] Ex parte notice, FCC ET Docket No. 13-49, April 14, 2016, submitted by Alliance of Automobile Manufacturers, Association of Global Automakers, DENSO International America, and Cisco Systems, Inc.
[17] Teodor Buburuzan: "C2C-CC roadmap beyond day 1", 8th ETSI ITS workshop, Sophia Antipolis, March 2016.
[18] Tiger Team report, "Appendix C: Cooperative ITS spectrum regulation in the 5GHz band in Europe"