CAR 2 CAR Communication Consortium c/o ITS mobility GmbH
Hermann-Blenk-Straße 17 • D–38108 Braunschweig • Germany

Office of Engineering and Technology
Federal Communication Commission
445 12th St., S.W.
Washington, D.C. 20554

CONTACT

General Manager of the CAR 2 CAR Communication Consortium

Niels Peter Skov Andersen

Løvparken 14
4000 Roskilde
Denmark

Phone +45 20 78 47 93

npa@car-2-car.org
www.car-2-car.org

Roskilde, 2019-01-18

RE: Office of Engineering and Technology Requests for Comments on "5GAA Petition for Waiver to Allow Deployment of Cellular Vehicle-To-Everything (C-V2X) Technology in the 5.9 GHz Band" (GN Docket No. 18-357)

Dear Mathew Hussey,

these comments are respectfully submitted by the CAR 2 CAR Communication Consortium to the Federal Communication Commission's Office of Engineering and Technology and the Wireless Telecommunication Bureau in response to the 5GAA Waiver to Allow Deployment of Cellular Vehicle-To-Everything (C-V2X) Technology in the 5.9 GHZ Band. All comments expressed in the following paragraphs are made in the interest of safety of life V2X applications and the efficient utilization of spectrum resources.

With best regards

Niels Peter Skov Andersen
General Manager
CAR 2 CAR Communication Consortium

About CAR 2 CAR Communication Consortium

In the CAR 2 CAR Communication Consortium, leading European vehicles manufacturers, equipment suppliers and research institutions 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 in Europe based on inter-vehicle and vehicle to roadside short-range communication for improving road safety and road efficiency. Other complementary communication like 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) and V2I (vehicle-to-infrastructure) 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 has been founded in 2002 with the objective of developing European 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 world-wide

Deployment

CAR 2 CAR Communication Consortium (C2C-CC) is convinced that a fast, successful and wide-scale deployment of V2X in the US and the EU is key for reducing the number of fatal accidents and supporting cooperative automated driving to reach the goal of zero fatalities from vehicle collisions.

Deployment Status:

The deployment of DSRC (a.k.a. IEEE 802.11p, pWLAN) in vehicles has already started in the United States in 2017 with General Motors[1] while several other vehicle manufacturers are currently in their commercialization phases (Toyota: launch by 2021[2], GM: further DSRC roll-out[3]). At the same time, most member states in the USA have initiated the DSRC deployment of infrastructure targeting Vehicle-to-Infrastructure (V2I) applications to enhance road safety (Figure 1). Introducing LTE C-V2X at this stage without performing compatibility studies with DSRC goes against the well-known processes of requesting access to spectrum resources which are currently designated to an incumbent technology.

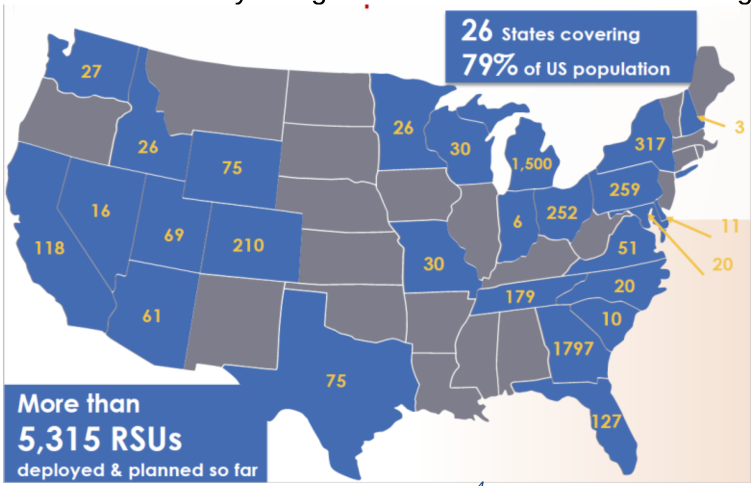

Figure 1: RSU deployment with DSRC in US[4]

In Europe, VW will start in 2019 the mass volume deployment of DSRC-based (pWLAN) V2X technology in its models while member states are equipping RSU at selected traffic hot spots.

[1] https://media.cadillac.com/media/us/en/cadillac/news.detail.html/content/Pages/news/us/en/2017/mar/0309-v2v.html

[2] https://corporatenews.pressroom.toyota.com/releases/toyota+and+lexus+to+launch+technology+connect+vehicles+infrastructure+in+u+s+2021.htm

[3] https://media.gm.com/media/us/en/cadillac/news.detail.html/content/Pages/news/us/en/2018/jun/0606-its-cadillac.html

[4] source: Toyota presentation on ITS WC Oct 2018, update on C2C-CC Forum Nov 2018, see also https://transportationops.org/spatchallenge

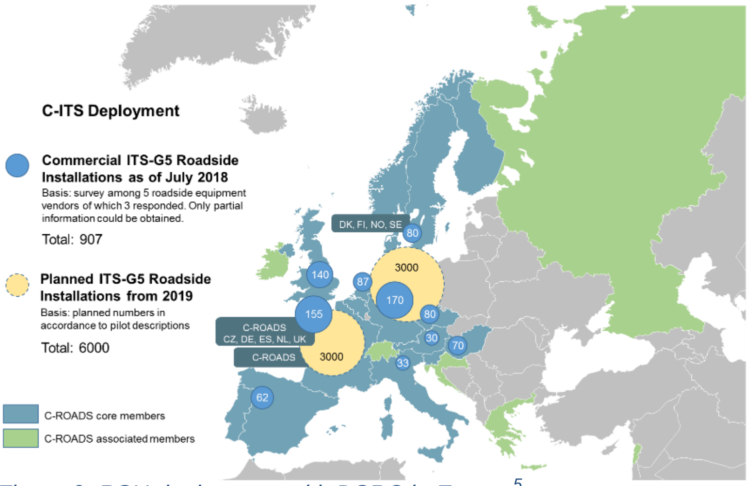

Figure 2: RSU deployment with DSRC in Europe[5]

Pushing for further deployment:
Europe and the US have adopted a voluntary V2X introduction for private and public stakeholders. Key in accelerating the deployment is to increase benefit/cost ratio for V2X for each stakeholder and its deployment decision.

Increased cost leads to delay in deployment:
The complexity and cost associated with the adoption of V2X technologies, irrespective of the specific communications protocol used, is undoubtedly very substantial. At the same time, the expected life-cycle of vehicles and infrastructure is much longer compared to that of most consumer products. These factors have caused vehicle manufacturers and road operators to take a cautious approach on the adoption of this technology.
If a new technology is introduced in the same frequency band offering the same services, then the first impact would be to introduce confusion leading to an unavoidable delay in the deployment of V2X technology in cars and roads. In turn, this will have a direct impact on the amount of human lives being lost on the road every year. Secondly, car manufacturers and road operators will most likely be forced to adopt both technologies, which will result in increased cost and complexity. Eventually this will lead to increased cost to the consumer, however without the latter enjoying any additional benefit.

Another cost issue for LTE C-V2X which remains unsolved, is related to the high timing accuracy required for the Time Division Multiple Access (TDMA) to ensure functioning in areas outside the coverage of satellite signals (e.g. tunnels, areas shadowed by mountains, urban canyons). This is another reason for increased cost of the LTE C-V2X equipment, if the service should not be limited when the accurate satellite signal is not available.

V2V, V2I, V2P Interoperability
Currently, a number of so-called “Day-1” applications are being targeted for the initial launching of DSRC technology. However, the deployment of “Day-2” applications (e.g., platooning) will follow soon after, requiring more spectrum resources. It is therefore crucial that all vehicle manufacturers ensure interoperability within wireless technologies for vehicle-to-vehicle and vehicle-to-infrastructure (V2X) communication, otherwise, the benefits of increasing traffic safety will diminish and the potential of saving lives will disappear.
V2V, V2I, V2P interoperability is technically defined as interoperability over all communication layers including the access layer. This is the only way to realize

---

[5] source: CEPT SRD/MG Dec. 2018, p.33 in “5a Austria ready-text.docx”
https://www.cept.org/Documents/srdmg/48465/srdmg-18-179_pc-summary-draft-cept-report-71

Functional Safety. Additionally, it leads to a more efficient use of spectrum which can support more applications and stations.

This means that a car equipped with LTE C-V2X technology shall be able to communicate with cars equipped with DSRC technology since DSRC is the technology already deployed in the US in 5.9 GHz. The V2V, V2I, V2P interoperability between DSRC and LTE C-V2X needs to be proven having in mind the latency requirement of such safety related applications.

Within the Institute of Electrical and Electronics Engineers (IEEE), the standard 802.11bd is being developed which will be fully backward compatible and interoperable with the existing DSRC 802.11p. In 3rd Generation Partnership Project (3GPP) a New Radio (NR) V2X standard is in development. LTE C-V2X is not seen compatible and interoperable with NR C-V2X, which would lead to requiring additional spectrum for NR C-V2X, as stated by 3GPP[6].

C2C-CC supports the need for interoperability within V2X technologies. Ignoring this aspect is a risk for safety on US roads. The usage of two or even more different technologies at 5.9 GHz aiming for the same purpose in the same frequency band and that cannot communicate with each other, will not be able to optimally reduce the number of accidents and incidents on US roads. Thus, for any new or emerging technology, including the above-mentioned, interoperability is the key because there needs to be a concept to communicate and understand all other (existing) vehicles. DSRC is already in place and automotive-grade hardware already exists.

Spectrum fragmentation

A division of the available spectrum resources will lead to a situation where the needs of V2X systems will not be met by either technology in the near future. From a spectrum view, at least the available 75 MHz[7] of bandwidth is required for V2X, regardless of the communication technology. This requirement urges any decision to avoid the duplication of any use case with a second technology and to avoid any spectrum fragmentation.

Environment	**BSM**	**SPAT_MAP traffic lights**	**PSM pedestrians**	**PCM platooning**	**CPM collective perception**	**MCM manoevering**	**MCM 1)**	**total spectrum requirement Σ**
Urban	10,6	0,1	5,1	3,5	13,0	7,4	7,4	47 MHz
safety relevance radius	100m	100m	50m	100m	100m	100m	100m	
Sub-Urban	9,9	0,0	0,2	3,5	14,7	8,4	8,4	45 MHz
safety relevance radius	150m	150m	50m	150m	150m	150m	150m	
Rural, Highway	9,9	0,2	0,0	8,7	20,4	11,6	11,6	62 MHz
safety relevance radius	500m	500m		500m	500m	500m	500m	
additional requirement for **Truck parking / Tollstation**				**17,5**			**Rural:**	**80 MHz**
safety relevance radius				200m				
additional requirement for **Urban square**			**34,9**				**Urban:**	**77 MHz**
safety relevance radius			50m					

Table 1: US spectrum requirement analysis independent of V2X technology based on known V2X message types and different environments[8]

[6] According to 3GPP: NR C-V2X is interoperable at the mobile network level where information can be translated and transmitted in the appropriate format, back and forward only

[7] including a 5 MHz guard band from 5850-5855 MHz.

[8] source C2C-CC white paper "Road Safety and Road Efficiency Spectrum Needs in the 5.9 GHz for C-ITS and Automation Applications" https://www.car-2-car.org/documents/

Table 1 summarizes the spectrum needs[9] of vehicle-to-vehicle, vehicle-to-infrastructure and vehicle-to-pedestrian communication (in the following called V2X) known today. The already known message types[10] of V2X are relevant to realize all V2X applications which are part of the V2X roadmap[11], additional messages with additional spectrum needs may come on top of that picture. Some messages like Basic Safety Message (BSM), Messages used by traffic lights (SPAT, MAP), Personal Safety Message (PSM) cover applications listed in the live saving category of safety in Connected vehicle Reference Implementation Architecture (CVRIA)[12] some of them like CPM, MCM, PCM go beyond CVRIA applications and climb the V2X roadmap towards cooperative automated driving.

The advanced types of applications in direction of V2X supporting automated driving as collective perception, cooperative maneuvering and truck platooning (based on CPM, MCM, PCM) are alone requiring 50 MHz spectrum bandwidth, already occupying five of the existing seven DSRC channels.

The analysis looks into 3 typical environments: slow and packed traffic in cities (Urban), medium moving traffic in suburban areas (Sub-Urban) and fast-moving traffic on highways (Rural) taking into account that different messages are sent with increasing update rates with increasing vehicle velocity.

The calculated spectrum needs are only based on relevant safety distances. For a vehicle at an urban intersection, 100 m of safety range is seen relevant from a safety perspective to be able to react in time, while 150m in a suburban and 500m on a highway are seen as relevant safety distances. Real communication ranges are, in general, much above these distances which lead to even more vehicles in communication range and higher spectrum needs. The maximum channel load is set to 50% to allow very low latencies for urgent safety messages at any time.

Urban: These low speed settings combined with low Tx rates lead to 47 MHz spectrum needs in urban environment or 77 MHz if such a crossing would be side by side with a square full of people.

Now looking into the rural, highway and high speed scenario:

On a highway traffic moves fast and vehicles driving with a greater safety distance to each other. Such a highway scenario sums up to 62 MHz of spectrum needs, even to 80 MHz taking a truck parking next to the highway into account.

In general, a technology specific band split would hinder any further technology evolution in the US.

With further studies to be done, FCC could open the ITS spectrum to additional V2X technologies when they have proven co-channel coexistence and interoperability with the deployed technologies and deployed use cases.

---

[9] Spectrum needs = $\frac{packet\ size \times periodicity \times ITS\ stations\ in\ comm\ range}{spectrum\ efficiency \times max\ channel\ load}$

[10] BSM Basic Safety Message

SPAT, Signal, Phase, and Timing (SPAT), ISO/TS 19091:2017

MAP ISO/TS 19091:2017

Pedestrian protection with Personal Safety Messages (PSM) according to SAE J2735, SAE J2945/9_201703 https://www.sae.org/standards/content/j2945/9_201703/

PCM Platooning Control Message, currently being drafted in the European H2020 project ENSEMBLE (multi-brand truck platooning) https://platooningensemble.eu/ https://platooningensemble.eu/news/using-its-g5-for-efficient-truck-platooning5c1a203e7a226

CPM Collective Perception Message, Draft TS 103 324

MCM Maneuver Cooperation Message, according to ETSI TR 103 578 (draft) “Informative report for the Maneuver Coordination Service”; https://imagine-online.de/en/home/

MCM 1) doubled spectrum resources needed for MCM if message size increases from 400 Byte to 800 Byte due to multiple traces. The requirement between 400 Byte and 800 Byte may change by different situations.

[11] See C2C-CC application roadmap https://www.car-2-car.org/fileadmin/downloads/PDFs/roadmap/CAR2CAR_Roadmap_Nov_2018.pdf

[12] https://local.iteris.com/cvria/html/applications/applications.html

The waiver asks for 20 MHz channel rather than two 10 MHz channels. There is not yet testing available to support a deployment using 20 MHz. Such a change of band plan would hinder coexistence between the V2X technologies. C2C-CC opposes to such a change of the available 10 MHz band plan.

Technical superiority

The 5GAA petition waiver claims “significant performance advantages … when measured against DSRC” however these claims can be questioned.

1. Unfair comparison between different settings for the two technologies.

Even though the 5GAA report claims to provide similar conditions for both technologies, a closer look reveals that:

- The C-V2X modem uses only half of the available 10 MHz bandwidth. This reduces the noise level experienced at the receiver by 3 dB compared to the DSRC modem.
- The C-V2X modem uses multiple transmissions of redundant information (HARQ) to improve the probability of reception (the effect is another 3 dB gain in sensitivity).

Although the above techniques are acceptable ways of improving the robustness and performance in a wireless communication system, they result in higher occupancy of the wireless medium compared to DSRC for transmitting the same amount of information. Moreover, some of those methods are only applicable in specific mid to low congestion conditions depending on the packet size to be transmitted. Looking to the spectrum needs of V2X and the available scarce spectrum resources this high occupancy of the spectrum cannot be taken as granted.
A fair comparison between the two technologies would have to either ensure that the air time is approximately equal for both technologies, or that the differences are considered by the use of an appropriate metric such as the energy per transmitted bit of information.

2. DSRC modem used is not representative of commercial devices being deployed

The comparison is based on a device which has a sensitivity which is at least 8 dB worse than any commercial DSRC device currently deployed[13] [14] [15]. Additionally, the report claims that the DSRC device used in this comparison is complaint with SAE J2945 however, a closer look shows that it clearly violates the required sensitivity by this standard. Many years of test trials in DSRC systems, under various conditions and from various companies have shown that the performance of DSRC is much better to that of the performance of the specific DSRC unit used in this report.

C2C-CC therefore asks the FCC to initiate some open trials where several OEMs and V2X equipment vendors can perform both small- and large-scale tests to verify the performance,

---

[13] CohdaMobility MK5 Datasheet https://fccid.io/2AEGPMK5RSU/User-Manual/User-Manual-2618067.pdf

[14] U-blox UBX-P3 Product Summary https://www.u-blox.com/sites/default/files/UBX-P3_ProductSummary_%28UBX-16013869%29.pdf

[15] A review of 5GAA’s “V2X Functional and Performance Test Report” P-180106 https://www.u-blox.com/sites/default/files/Comments-on-5GAA-PetitionWaver-18-357.pdf

maturity, compatibility, interoperability of any new V2X technology before deciding upon such a waiver.

Besides its other benefits like cost-efficiency and maturity, DSRC is chosen by infrastructure owners/operators and OEMs such as GM and Toyota for its very low latency of 2 ms in most scenarios and 5ms in all scenarios including congested situations. This benefit is not captured in the report correctly.

Conclusion

For all of these reasons, the petition is counter to the public good and should be rejected.