Deployment band configuration for C-V2X at 5.9 GHz in Europe

5GAA Automotive Association

Position paper

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1. Introduction

European administrations have designated the bands 5855-5875 MHz and 5875-5925 MHz – referred to as the 5.9 GHz band – for use by road Intelligent Transport Systems (ITS) as specified in ECC Recommendation (08)01 [1] and ECC Decision (08)01 [2], respectively, both of which were approved by the ECC (CEPT) in March 2020. These are complemented by Decision 2020/1426 of the European Commission as adopted in October 2020 [3]. As is common practice in Europe, the spectrum is designated on a technology neutral basis.

Industry is planning for the deployment of C-V2X (LTE-V2X and NR-V2X) technologies for direct communications (via the PC5 interface) in the 5.9 GHz band. In order to ensure homogeneity and interoperability across the industry, 5GAA believes that an agreement by the C-V2X industry is required with regards to the specific channels where C-V2X should be deployed in the 5.9 GHz band; that is to say, a "deployment band configuration".

This position paper describes 5GAA's view on such a deployment band configuration for C-V2X in the 5.9 GHz band. A consensus by the C-V2X industry on the deployment band configuration would allow a situation where C-V2X equipment using the 5.9 GHz band can be configured identically in all vehicles, thereby paving the way to interference-free operation of ITS services across Europe.

The deployment band configuration outlined in this paper addresses the initial deployment of C-V2X technologies.

1.1 Spectrum regulations in Europe

European spectrum regulations for the frequency ranges 5855-5875 MHz and 5875-5935 MHz are technology neutral and are specified in ECC Recommendation (08)01 [1] and ECC Decision (08)01 [2], respectively, both of which were approved by the ECC (CEPT) in March 2020.

The corresponding band plan is illustrated in Figure 1.

Specifically, 5855-5875 MHz is designated for non-safety road-ITS, whereas 5875-5935 MHz is designated for safety related ITS. Furthermore, 5875-5915 MHz and 5915-5925 MHz are prioritised for road-ITS and rail-ITS applications, respectively, and with the frequency range 5925-5935 MHz available only for rail-ITS. The operation of on-board units (OBUs) and road-side units (RSUs) are authorised though licence exemption.

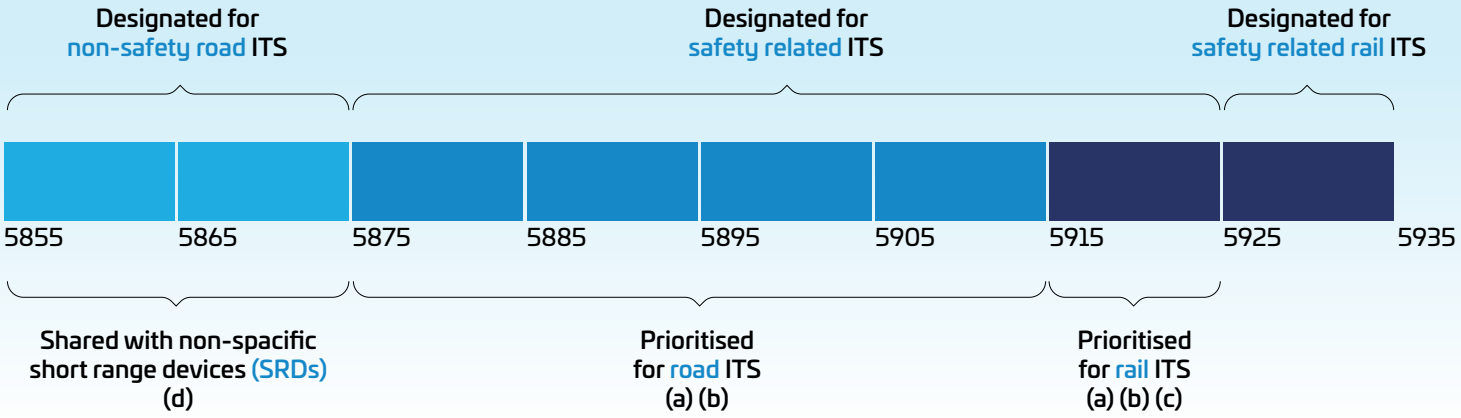

Figure 1: Spectrum designations at 5.9 GHz in Europe.
See below for descriptions of (a)-(d).

The following points should be noted in relation to Figure 1:

a) No harmful interference shall be caused to the application having priority.

b) Road-ITS and rail-ITS shall remain confined to their respective prioritised frequency range until such time when appropriate spectrum sharing solutions are defined by ETSI (but see (c)).

c) Vehicle-to-vehicle (V2V) communications for road-ITS may only be permitted at 5915-5925 MHz once spectrum sharing solutions for the protection of rail-ITS have been developed at ETSI. In the absence of such sharing solutions for the protection of rail-ITS, national administrations may permit infrastructure-to-vehicle (I2V) communications for road-ITS at 5915-5925 MHz subject to coordination with rail-ITS.

d) Use of spectrum in the frequency range 5855-5875 MHz is on a non-interference/non-protected basis [4], and includes use by non-safety road-ITS and non-specific short range devices.

Market access in the European Union is governed through the European Radio Equipment Directive (RED) [5] whose essential requirements are addressed by the related ETSI Harmonised Standards. Conformance with the essential requirements of the RED in the context of ITS at 5.9 GHz can be demonstrated through compliance with the technical specifications defined in ETSI EN 302 571 [6].

1.2 Spectrum regulations in other regions

The designation and authorisation of the 5.9 GHz band for use by ITS, and C-V2X in particular, is under discussion in several regions around the globe.

China

In October 2018, the MIIT made a decision to make 5905-5925 MHz available for use by LTE-V2X (PC5) in China on a technology specific basis, with the lower 10 MHz block for V2V communications, and the upper 10 MHz block for V2I/I2V communications. The operation of OBUs and RSUs are authorised though licence exemption and licensing, respectively.

United States

In November 2020, the FCC adopted a Report & Order (R&O) in docket number 19-138 [7] revising its rules for the 5850-5925 MHz band, which had been dedicated exclusively for DSRC since 2003. The R&O reallocated the lower 45 MHz of the 5.9 GHz band (5850-5895 MHz) from DSRC to unlicensed use for technologies such as Wi-Fi, and concluded that the United States should move forward with C-V2X in the 5895-5925 MHz portion of the band[1].

1.3 5GAA spectrum needs study

In 2020, 5GAA published a comprehensive study of the spectrum requirements of ITS services [8][9]. The results of the 5GAA study are essential in determining the required amount of bandwidth for Day-1 and advanced use cases to be delivered by C-V2X for direct communications in the 5.9 GHz band. It is the view of 5GAA that LTE-V2X is the most suitable technology for the support of Day-1 (basic safety) ITS use cases at 5.9 GHz, and that NR-V2X will complement LTE-V2X to address advanced ITS use cases in the future.

Based on the results of the study, we drew the following conclusions:

a) We expect that the delivery of day-1 use cases via LTE-V2X for the support of basic safety ITS services will require between 10 and 20 MHz of spectrum at 5.9 GHz for V2V/I communications.

b) We expect that the delivery of advanced use cases via LTE-V2X and NR-V2X for the support of advanced driving services will require an additional 40 MHz or more of spectrum at 5.9 GHz for V2V/I/P communications.

These conclusions clearly indicate that the entire 70-75 MHz of ITS spectrum in the 5.9 GHz band (as presently allocated in many regions and under consideration in other regions) is needed to support the basic safety and advanced use cases under consideration today.

[1] Existing DSRC systems would be given one year from the effective date of the R&O to cease operations in the lower 45 MHz; the timing of the technology migration from DSRC to C-V2X in the upper 30 MHz is the subject of a Further Notice of Proposed Rulemaking (FNPRM) that was released concurrently with the R&O.

2. Proposed deployment band configuration for C-V2X

In light of our estimated spectrum needs for Day-1 (basic safety) and advanced use cases, we present below 5GAA's position on the deployment band configuration for C-V2X at 5.9 GHz in Europe.

2.1. Background

As discussed in Section 1, the availability of spectrum for ITS in Europe is broadly aligned with the globally harmonized 5850-5925 MHz band as defined by the ITU-R [10]. Specifically, 5855-5875 MHz is designated for non-safety road-ITS, whereas 5875-5935 MHz is designated for safety related ITS. This availability is on a technology neutral basis.

As such, a deployment band configuration for the use of the 5.9 GHz band by C-V2X in Europe may be developed by taking account of the following important observations:

1) In Europe, both 3GPP (C-V2X) and non-3GPP IEEE (ITS-G5) technologies are expected to compete for the ITS market. Current deployments of ITS-G5 OBUs operate in the 5895-5905 MHz block for the provision of safety related ITS use cases. It might be expected that ITS-G5 will continue to operate at 5895-5905 MHz for a number of years. This must be accounted for in any deployment roadmap for C-V2X.

2) The first waves of LTE-V2X OBUs deployed for operation at 5.9 GHz will include radios with a PC5 carrier bandwidth of up to 20 MHz. This is consistent with the 3GPP requirements for C-V2X devices which mandate support of channel bandwidths of 10 and 20 MHz, as well as 5GAA studies which indicate that Day-1 safety related ITS use cases require between 10 and 20 MHz of bandwidth at 5.9 GHz.

3) In order to benefit from economies of scale in equipment, it is important for the deployment of LTE-V2X in Europe to be aligned – to the greatest extent possible – with C-V2X deployments in other regions, in particular the US (5895-5925 MHz) and China (5905-5925 MHz).

2.2. Proposed deployment band configuration

Figure 2 below illustrates the proposed deployment band configuration for use of the 5.9 GHz band by C-V2X in Europe accounting for the factors outlined above.

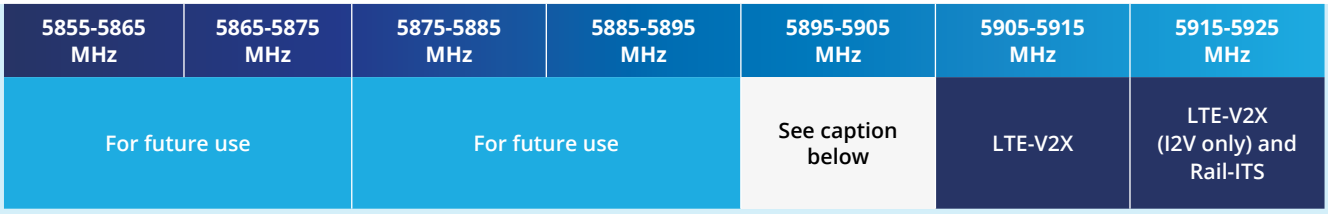

Figure 2: Deployment band configuration for C-V2X at 5.9 GHz in Europe.
5GAA does not at this stage take a position on the use of 5895-5905 MHz by C-V2X.

The key elements of the proposed deployment band configuration are as follows:

- In order to maximise alignment with the technology specific channel allocations in the US and China, and also to avoid co-channel operation with ITS-G5, LTE-V2X should be deployed at 5905-5925 MHz in Europe for the provision of Day-1 safety related use cases. Such deployment can happen today without modifications to 3GPP specifications or existing products.
- In accordance with European regulations, the channel at 5915-5925 MHz is prioritised for rail-ITS, and in the absence of road-ITS/rail-ITS coexistence solutions to be developed at ETSI, the deployment of road-ITS technologies at 5915-5925 MHz are restricted to I2V communications, and will in any case be subject to authorisation by individual national administrations. For this reason, we do not expect early road-ITS deployments in this channel in all countries, and so deployments at 5905-5915 MHz are prioritised.
- The deployment of NR-V2X at 5875-5895 MHz (e.g., based on a 20 MHz carrier) is for further study. This would be for the provision of advanced safety related use cases as a complement to LTE-V2X which will continue to provide Day-1 safety related use cases.
- Also for further study is the deployment of NR-V2X at 5855-5875 MHz which is currently designated for non-safety road-ITS in Europe. It should be pointed out that operation at 5855-5875 MHz would be co-channel with existing licence exempt non-specific short range devices (SRDs), and therefore subject to technical requirements (operation on a non-interference/non-protected basis) that are more restrictive than those which apply above 5875 MHz in the 5.9 GHz band.

2.3. Technical challenges

Based on the above deployment band configuration, the following technical challenges can be identified:

- **Channelisation** – Today, the regulations only permit a 10 MHz channelisation in the 5.9 GHz band. Revisions of ECC Decision (08)01, ECC Recommendation (08)01, and ETSI EN 302 571 are required to allow 20 MHz (or wider) deployments of NR-V2X at 5855-5895 MHz.
- **Inter-technology coexistence and risks to safety** – There is an ongoing coexistence work item at ETSI to investigate the viability of co-channel coexistence between LTE-V2X and ITS-G5 in the 5.9 GHz band. Such co-existence will inevitably negatively impact the ability of the two technologies to deliver safe and reliable communications; and will potentially also impact the specifications of the technologies and the complexity of the products.
- **Deployment at 5915-5925 MHz** – Mechanisms for road-ITS to share these frequencies with the prioritised rail-ITS are not yet defined at ETSI, and this is a prerequisite for deployment of road-ITS V2V communications at these frequencies.

3. Conclusions

It is the view of 5GAA that the C-V2X industry needs to agree on a commonly applied and unique deployment band configuration for C-V2X direct communications in the 5.9 GHz band. With such an agreement, C-V2X equipment can be configured identically in all vehicles for operation in the 5.9 GHz band, thereby paving the way to interference-free operation of ITS services across Europe.

5GAA position on a deployment band configuration for C-V2X at 5.9 GHz in Europe

- 5GAA notes that the 5.9 GHz band is designated by CEPT and the European Commission for use by ITS in Europe on a technology neutral basis, and that the choice of the technologies used is up to industry (subject to compliance with the technology neutral regulatory requirements);
- 5GAA considers that LTE-V2X should be deployed for Day-1 basic safety related applications, requiring between 10 and 20 MHz of spectrum at 5.9 GHz;
- 5GAA considers that NR-V2X is expected to be deployed for advanced safety and non-safety related applications, requiring an additional 40 MHz or more of spectrum at 5.9 GHz beyond Day-1 basic safety related applications;
- 5GAA supports an industry-led agreement on deployment of C-V2X in specific channels at 5.9 GHz as outlined below:
    - 5855 – 5875 MHz: Advanced driving applications (non-safety) - for further consideration;
    - 5875 – 5895 MHz: Advanced driving applications (safety) - for further consideration;
    - 5895 – 5905 MHz: No position at this stage on the use of this channel by C-V2X;
    - 5905 – 5915 MHz: Day-1 basic safety related applications using LTE-V2X (10 MHz channel);
    - 5915 – 5925 MHz: Infrastructure-to-vehicle safety related applications using LTE-V2X (10 MHz channel).

References

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[3]	European Commission, "Commission Implementing Decision (EU) 2020/1426 of 7 October 2020 on the harmonised use of radio spectrum in the 5 875-5 935 MHz frequency band for safety-related applications of intelligent transport systems (ITS) and repealing Decision 2008/671/EC (notified under document C(2020) 6773)", October 2020, available at http://data.europa.eu/eli/dec_impl/2020/1426/oj.
[4]	European Commission, "Commission implementing decision (EU) 2019/1345, amending Decision 2006/771/EC updating harmonised technical conditions in the area of radio spectrum use for short-range devices", August 2019, available at https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32019D1345&from=EN.
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