5GAA Automotive Association

5.9 GHz band configuration for road-ITS deployment 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 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 5G-V2X technologies for direct communications (via the PC5 interface, also known as the sidelink) in the 5.9 GHz band. 5G-V2X relates to automotive-relevant 3GPP 5G technologies and it is composed of a network-based (Uu) and direct (PC5) communication mode operated with or without LTE-V2X. 5G-V2X addresses advanced use cases, however it also supports all previous message types, including basic safety messages, in order to deliver service continuity.

In order to ensure cross-industry harmonisation and interoperability, 5GAA believes that an agreement by the automotive industry is required with regards to the specific channels, where different ITS radio technologies, including 5G-V2X, should be deployed in the 5.9 GHz band – a so-called "deployment band configuration".

The need for an industry agreement is further motivated by the outcome of the work in ETSI on the topics of co-channel coexistence (ETSI TR 103 766) and spectrum-sharing frameworks (ETSI TR 103 667) at 5.9 GHz. In its October 2022 Liaison Statement [4] to CEPT WG FM, ETSI states:

> "While ETSI has proposed several coexistence mechanisms in the aforementioned technical reports, there is no consensus within ETSI as to which of these mechanisms is to be selected. The proposed mechanisms have an impact on existing standards and equipment. There is no agreement in ETSI on how this impact should be borne by the implementers of the different road-ITS technologies. In summary, given the multidimensional nature of road-ITS coexistence and the diverging views within ETSI, there is no consensus on the selection of a single road-ITS coexistence method. Furthermore, there is no consensus on whether any of the proposed coexistence methods can fulfil the WG FM principles and guidance in full. Furthermore, additional work in ETSI might not lead to consensus on a specific solution allowing different technologies to coexist in the same channels. In case that an agreement on a way forward is reached by ITS stakeholders outside of ETSI, then ETSI will be able to continue the work as and when required."

Subsequently, CEPT ECC sent a letter [5] to the European Commission stating that:

> "CEPT welcomed ACEA/CLEPA's initiative to organise dialogue between industry organisations representing road- ITS applications and deployments (e.g. CEDR, C-Roads, ASECAP, C2C-CC, 5GAA, ACEA, CLEPA, POLIS, etc.). CEPT understands that the aim of this dialogue is to come to an agreement on a way forward on the coexistence issue. A feedback to both WG FM #104 and ETSI is expected by February 2023."

This position paper describes 5GAA's view on a possible industry agreement to resolve the coexistence issue. The main goal is to propose a deployment band configuration for road-ITS in the 5.9 GHz band with the aim of minimising the risk of mutual co-channel interference across different road-ITS technologies. Furthermore, 5GAA believes that a consensus by the automotive industry on the deployment band configuration would allow a situation where 5G-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 paper only addresses operation in 5.9 GHz and therefore the sidelink component of 5G-V2X.

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 band plan corresponding to ECC Recommendation (08)01 and ECC Decision (08)01 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.

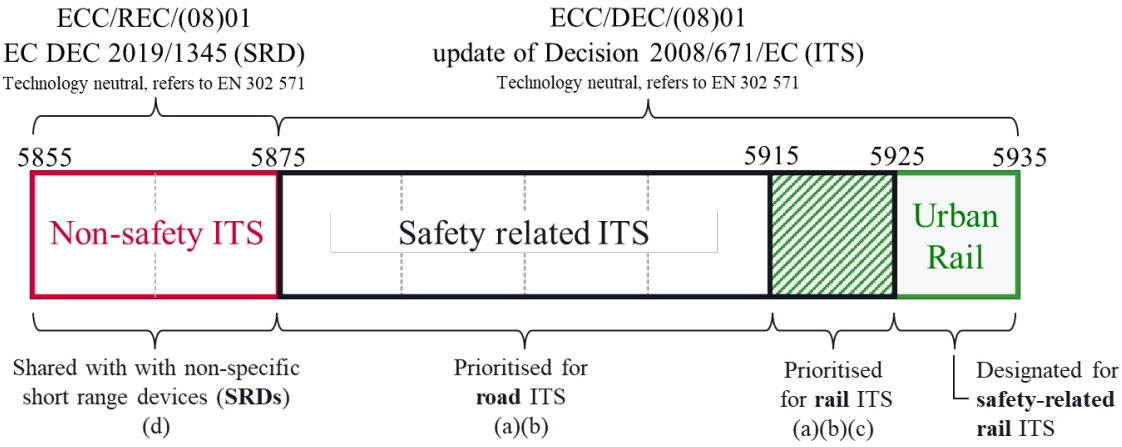

Figure 1: Spectrum designations at 5.9 GHz in Europe.
See below for descriptions of (a)-(d).

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) 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. 5GAA spectrum needs study

5GAA has published a comprehensive study of the spectrum requirements of ITS services [7]. 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 5G-V2X for direct communications in the 5.9 GHz band.

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

a) We expect that the delivery of day-1 use cases 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 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.

2. Proposed deployment band configuration for road-ITS

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 road-ITS 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 harmonised 5850-5925 MHz band as defined by the ITU-R [9]. 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 5G-V2X in Europe may be developed by taking account of the following important observations:

1) In Europe, both 3GPP and non-3GPP IEEE technologies are expected to operate in the 5.9 GHz band. Current deployments of ITS-G5 OBUs operate in the 5895-5905 MHz block for the provision of safety related ITS use cases. It is 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 5G-V2X.

2) 5G-V2X OBUs are expected to be deployed for the provision of advanced use cases with a PC5 carrier bandwidth of up to 20 MHz[1].

3) It is expected that up to 40 MHz are needed for the delivery of advanced use cases to support advanced driving services. This is consistent with the current designation of 5.9 GHz band as summarised in Figure 1, considering both safety and non-safety road-ITS spectrum. Therefore, the proposals presented in this paper do not imply the need for any additional spectrum beyond what is made available in the current European regulations.

In terms of European standardisation activities, ETSI has developed a set of standards addressing Cooperative-ITS (C-ITS) applications and use cases.

In the ETSI ITS Release 1 specification set [10], C-ITS is based on 3GPP Release 14. The LTE-V2X sidelink access layer standard, EN 303 613 V1.1.1 contains a set of references to 3GPP Release 14 and essential configuration values for European deployments of LTE-V2X sidelink.

In the ETSI ITS Release 2 specification set [11], C-ITS will be extended to include NR-V2X sidelink. The 5G-V2X access layer standard, EN 303 798, which is currently being drafted

[1] Advanced use cases will largely benefit from deployment with a 20 MHz channel bandwidth. The possibility of using a 20 MHz channel bandwidth is conditioned on the update of the 5.9 GHz spectrum regulations in Europe. In the event that the current spectrum regulations are not updated, the same use cases could be deployed with two contiguous and independent 10 MHz channels, at the cost of increased complexity and lower efficiency.

and is scheduled for TC approval in March 2023, will contain a set of references to 3GPP Release 16 for NR-V2X and LTE-V2X, and essential configuration values for European deployments. ETSI Release 2 specifications will enable both day-1 and advanced driving use cases.

The ETSI ITS Release 1 specification set also contains ITS-G5 based on IEEE 802.11p. In the Release 2 specification set, ITS-G5 will be extended to include IEEE 802.11bd.

2.2. Use cases and applications

In its roadmap [8] published in November 2022, 5GAA sets out a consolidated view of the automotive and telecommunications industries on the evolution of communication technologies, their application to automotive connectivity, and the deployment of advanced driving use cases up to 2030, which include advanced safety and automated driving. In this roadmap, 5GAA identified a number of promising advanced driving use cases, which can be supported by C-V2X for direct communications, including [12] [13] [14] [15]:

- Group Start – Whereby self-driving or semi-automated vehicles at a traffic light form a group to jointly start and proceed ahead together.
- Collaborative Adaptive Cruise Control – An extension of the adaptive cruise control concept which realises longitudinal automated vehicle control by adapting speed and distance according to the preceding vehicle.
- Cooperative Manoeuvres – Whereby an automated vehicle identifies a difficult or dangerous situation (e.g. collision with a moving object) and undertakes to coordinate with neighbouring automated vehicles in order to perform joint manoeuvres.
- Dynamic Cooperative Traffic Flow – A multi-step process whereby: 1) the main traffic participant wishes to perform a certain action (e.g. lane change, highway exit, U-turn, etc.) and 2) shares this intention with other traffic participants potentially involved in the manoeuvre, 3) the informed traffic participants indicate to the main traffic participant their acceptance of (or objection to) the planned manoeuvre, and 4) the main traffic participant informs a superset of the traffic participants informed in the second step whether it plans to perform the manoeuvre.
- VRU Complex Interactions – Whereby a VRU is preparing to cross the street, and after sharing this intention, nearby vehicles send an acknowledgement to reassure the VRU that it is safe to cross. As the VRU is crossing, it continues to communicate with stopped vehicles, and informs the vehicles when it has cleared the zone.
- Sharing of Data on Dynamic Objects – Whereby vehicles/infrastructure collect information about dynamic objects and other traffic participants on or near the road based on their sensors and – once processed/analysed – share the relevant information including some metadata.
- Dynamic Intersection Management – Whereby an autonomous vehicle

approaching an intersection with traffic lights goes through (or stops) taking signal timing into account, and traffic flow is coordinated with other traffic participants dynamically.

These advanced C-ITS functions expand the breadth of basic safety provided in day-1 implementation, and lay a foundation for a transformative safe and efficient future with Cooperative, Connected and Automated Mobility (CCAM) at its centre. Advanced physical layer functionalities implemented by 5G-V2X sidelink radio are the enablers to meet Key Performance Indicators (KPIs) required by these use cases, as summarised in Table 1:

Table 1. Advanced C-ITS use cases and KPIs.

	Utilisation of feedback	Enhanced latency	Enhanced throughput
Group Start	Yes	≤ 10 ms	300 bytes @ 20 Hz / user
Collaborative Adaptive Cruise Control	Yes	≤ 100 ms	400 bytes @ 10 Hz / user
Cooperative Manoeuvres	Yes	≤ 10 ms	48 kbps / user
Dynamic Cooperative Traffic Flow	Yes	≤ 10 ms	48 kbps / user
VRU Complex Interactions	Yes	≤ 100 ms	64 kbps / user
Sharing of Data on Dynamic Objects	No	≤ 100 ms	1400 bytes @ 10 Hz / user
Dynamic Intersection Management	Yes	≤ 100 ms	300 bytes @ 10 Hz / vehicle 300 bytes @10 Hz / pedestrian 8 kbps / intersection

2.3. Proposed deployment band configuration

Figure 2 below illustrates the proposed deployment band configuration for using the 5.9 GHz band by 5G-V2X in Europe while accounting for the factors outlined above.

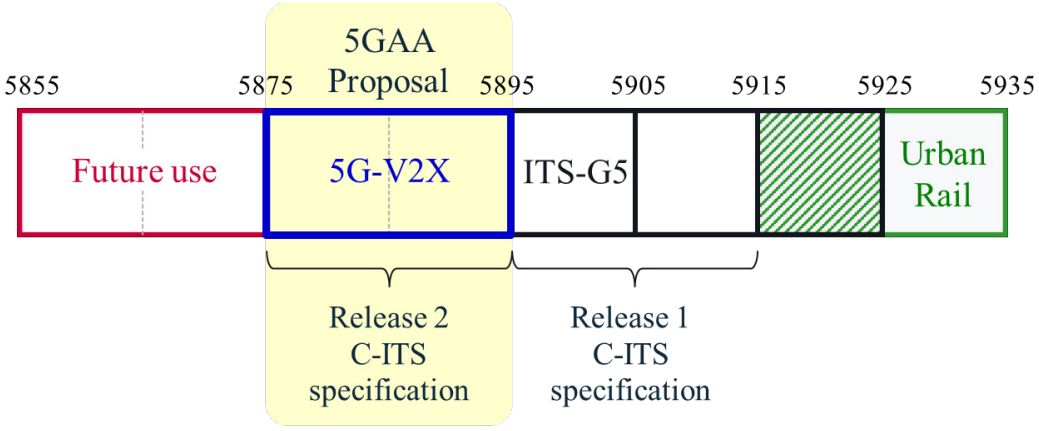

Figure 2: Proposed deployment band configuration for 5G-V2X at 5.9 GHz in Europe.

5GAA does not at this stage take a position on the use of the 5905-5915 MHz channel by 5G-V2X.

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

- The band plan is based on a channelisation which takes into account the possibility to deploy different message types and associated services in different portions of the band. The goal is to match spectrum needs and optimise the distribution of different services across the band.
- We propose to deploy services based on Release 1 C-ITS specifications [10] in the frequency range 5895-5915 MHz. In this portion of the spectrum, 5895-5905 MHz is currently used by ITS-G5 and its operation is expected to continue in this channel[2].
- We propose to deploy messages based on Release 2 C-ITS specifications [11] in the frequency range 5875-5895 MHz. In this part of the spectrum, 5GAA proposes a deployment based on 5G-V2X sidelink.
- 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.
- The deployment of 5G-V2X at 5855-5875 MHz, which is currently designated for non-safety road-ITS in Europe, is a topic for further study. 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 might be more restrictive than those which apply above 5875 MHz in the 5.9 GHz band.

2.4. Benefits of 20 MHz channelisation

5GAA believes that the possibility of using 20 MHz wide channels will be instrumental for the deployment of advanced use cases. It is indeed expected that the use cases described in Section 2.2 will be more demanding in terms of spectrum resources compared to day-1 use cases [7]. It is therefore a natural choice to deploy those services with a larger channel bandwidth, e.g. 20 MHz. There are several benefits associated with wider channels, including better spectral efficiency, more flexibility in multiplexing different use cases, and reduced complexity. This is because of the higher number of available frequency resources available in a 20 MHz channel compared to the aggregation of smaller channels[3]. Wider channels allow for more efficient load balancing and congestion control due to increased statistical multiplexing gain, resulting in greater communications range and faster message transmission rates. The

[2] For channel 5905-5915, 5GAA had previously proposed a deployment based on LTE-V2X [16].

[3] For transmissions using two adjacent channels with 10 MHz bandwidth each, guard bands would be necessary to account for the roll-off of spectrum masks, thus decreasing the total amount of frequency resources available. On the other hand, in the case of one continuous channel with 20 MHz bandwidth, no gap within the 20 MHz channel is needed, thus increasing the overall spectrum utilisation.

possibility to use wide channels also enables simpler equipment implementation, by reducing the number of receivers and transmitter needed to support more advanced use cases.

In summary, 5GAA strongly recommends the revision of the spectrum regulatory framework in Europe to allow 20 MHz channels.

2.5. Implications on regulation and standardisation activities

The deployment band configuration proposed above will have the following implications:

- **Channelisation** – Today, the spectrum regulations in Europe only allow a 10 MHz channelisation in the 5.9 GHz band. Given the benefits of 20 MHz channelisation outlined in earlier, the regulations should be updated to allow such 20 MHz deployments. Revisions of ECC Decision (08)01, ECC Recommendation (08)01, and ETSI EN 302 571 are required to allow 20 MHz deployments of 5G-V2X at 5855-5895 MHz. ETSI has developed a System Reference Document (SRdoc) which provides justification and technical parameters for CEPT to undertake relevant coexistence studies. These studies are a prerequisite for the revision of the ECC Decision and Recommendation. An update of the ETSI EN 302 571 would be subsequent to that revision.
- **Avoiding co-channel operation and mitigating risks to safety** – ETSI has been investigating co-channel coexistence mechanisms for a number of years. Despite thorough technical analysis, ETSI has not been able to agree on a technical solution which could meet all the target requirements for the band [4]. The band configuration proposed in this paper implies that the existing road-ITS technologies will not be required to operate co-channel. As such, 5GAA believes that an industry agreement on the proposed band configuration will minimise the risk of mutual interference between different technologies. Therefore, the band plan presented in this paper with respect to road- ITS technology deployment does not require changes to the existing regulations and standards.
- **Deployment at 5915-5925 MHz** – Mechanisms for road-ITS to share these frequencies with the prioritised rail-ITS are yet to be defined by 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 road-ITS industry needs to agree on a commonly applied and unique deployment band configuration for road-ITS direct communications in the 5.9 GHz band in Europe. With such an agreement, road-ITS 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 5.9 GHz band configuration for road-ITS deployment 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 supports an industry-led agreement on deployment of road-ITS in specific channels at 5.9 GHz as outlined below:
  - 5855 – 5875 MHz: advanced driving applications (non-safety) – for further consideration;
  - **5875 – 5895 MHz: services based on Release 2 C-ITS specifications, delivered via 5G-V2X sidelink;**
  - 5895 – 5915 MHz: services based on Release 1 C-ITS specifications, delivered via ITS-G5 in 5895-5905 MHz.
- 5GAA supports the necessary update of the existing regulation to enable 20 MHz channels in the 5.9 GHz band.

References

[1]	European Electronics Communications Committee, "ECC Recommendation (08) 01 on the use of the band 5855-5875 MHz for Intelligent Transport Systems (ITS)," February 2008 and amended on March 2020, available at https://www.ecodocdb.dk/download/798c1836-20c6/REC0801.pdf
[2]	European Electronics Communications Committee, "ECC Decision (08) 01on the Harmonised use of safety related Intelligent Transport Systems (ITS) in the 5875-5935 MHz frequency band," March 2008 and amended on March 2020, available at https://www.ecodocdb.dk/download/b470d271-048b/ECCDEC0801.pdf
[3]	European Commission, "Commission Implementing Decision (EU) 2020/1426 of 7 October 2020 on the harmonised use of radio spectrum in the 5875-5935 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]	FM(22)116, "LS from ETSI on coexistence solutions for ITS".
[5]	ECC(22)057 Annex 21,"Letter to the EC on ITS".
[6]	ETSI, "EN 302 571: Intelligent Transport Systems (ITS); Radiocommunications equipment operating in the 5855 MHz to 5925 MHz frequency band; harmonised standard covering the essential requirements of article 3.2 of Directive 2014/53/EU," February 2017, available at https://www.etsi.org/deliver/etsi_en/302500_302599/302571/02.01.01_60/en_302571v020101p.pdf
[7]	5G Automotive Association, "Study of spectrum needs for safety related Intelligent Transportation Systems – day 1 and advanced use cases," October 2021, available at https://5gaa.org/updated-study-of-spectrum-needs-for-safety-related-intelligent-transportation-systems-day-1-and-advanced-use-cases/
[8]	5G Automotive Association, "A visionary roadmap for advanced driving use cases, connectivity technologies, and radio spectrum needs," November 2022, available at https://5gaa.org/news/5gaa-publishes-updated-2030-roadmap-for-advanced-driving-use-cases-connectivity-technologies-and-radio-spectrum-needs
[9]	ITU-R, "Harmonisation of frequency bands for Intelligent Transport Systems in the mobile service," M2121-0, January 2019.
[10]	ETSI TR 101 607 V1.2.1 (2020-02) Intelligent Transport Systems (ITS); Cooperative ITS (C-ITS); Release 1. https://www.etsi.org/deliver/etsi_tr/101600_101699/101607/01.02.01_60/tr_101607v010201p.pdf
[11]	ETSI TR 101 607 V2.x.x (202x-xx) Intelligent Transport Systems (ITS); Cooperative ITS (C-ITS); Release 2. In preparation. ETSI work item reference RTR/ITS-218.
[12]	5G Automotive Association, "System enablers and best practices for next-gen cooperative use cases," November 2022, available at https://5gaa.org/news/system-enablers-and-best-practices-for-next-gen-cooperative-use-cases-5gaa-report
[13]	5G Automotive Association, "TR C-V2X Use Cases and Service Level Requirements Vol I," December 2020, available at https://5gaa.org/news/c-v2x-use-cases-and-service-level-requirements-volume-i
[14]	5G Automotive Association, "TR C-V2X Use Cases and Service Level Requirements Vol II," January 2021, available at https://5gaa.org/news/c-v2x-use-cases-and-service-level-requirements-volume-ii
[15]	5G Automotive Association, "TR C-V2X Use Cases and Service Level Requirements Vol III," January 2023, available at https://5gaa.org/content/uploads/2023/01/5gaa-tr-c-v2x-use-cases-and-service-level-requirements-vol-iii.pdf
[16]	5G Automotive Association, "Deployment band configuration for C-V2X at 5.9 GHz in Europe," June 2021, available at https://5gaa.org/news/deployment-band-configuration-for-c-v2x-at-5-9-ghz-in-europe

5GAA is a multi-industry association to develop, test and promote communications solutions, initiate their standardisation and accelerate their commercial availability and global market penetration to address societal need. For more information such as a complete mission statement and a list of members please see https://5gaa.org


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