Position Paper

www.5GAA.org

Coexistence of C-V2X and ITS-G5 at 5.9GHz

05 April 2018

1. Summary

Today the European market has interest in two distinct technologies for Intelligent Transport Systems (ITS) and the provision of vehicle to vehicle communications; namely 3GPP Cellular Vehicle-to Everything C-V2X and ITS-G5, based on IEEE 802.11p.

The technology neutral nature of spectrum regulations in Europe means that both C-V2X, and ITS-G5 have equal rights to operate in the 5.9 GHz band, subject to compliance with the relevant regulatory technical conditions.

In this paper we address the issue of co-channel coexistence between the two technologies at 5.9 GHz. We note that this is a critically important issue for the ITS industry, and that it is beneficial for all stakeholders to arrive at a proportionate, fair, and pragmatic solution to resolve this matter, and allow the market to proceed with the deployment of ITS equipment. To be clear, it is not the objective of this paper to compare and contrast the relative merits of these two technologies, although the 5GAA is a proponent of C-V2X as today's realisation of a platform to evolve towards 5G technologies.

The current realisation of C-V2X is LTE-V2X and encompasses two interfaces:

a) *The wide area network LTE interface (Uu) that connects end-user devices and vehicles to base stations (eNBs) and the core network, to provide vehicle to network (V2N) services. LTE-V2N can be supported by spectrum harmonised and designated for mobile communication networks;*

b) *The direct communications interface (PC5) that connects vehicles to vehicles (V2V), to roadside infrastructure (V2I) and to pedestrians (V2P), for the provision of low-latency and high-reliability V2V/I/P services independently of any MNO relationship and cellular network availability. LTE-V2V/I/P can be supported by spectrum that is harmonised for ITS, namely 5.9 GHz in Europe. The direct communication mode does not require coverage by a cellular network, or a V2N connection.*

To this end, we propose a spectrum sharing solution based on technology detection and dynamic frequency/channel selection – to be agreed among the stakeholders – to be implemented in up to three steps. In all steps, each of C-V2X and ITS-G5 can operate safety-related ITS services free from co-channel interference from the other technology.

The difference between the distinct steps lies in the overall usage of the spectrum resource: In the short-term first step, we propose to specify preferred 10 MHz channels at 5875-5905 MHz to each of the two technologies, while in the longer term third step, the solution will allow full sharing of all available channels by the two technologies. The latter will require further studies on appropriate sharing mechanisms and thus cannot be provided from the beginning.

We further explain how such a first step spectrum sharing of 5875-5905 MHz with a preferred channel for each technology might be complemented by additional technical mechanisms which would – where needed – allow

each of C-V2X and ITS-G5 to access the remaining 20 MHz in a fair manner, with a reduced risk of harmful co-channel interference.

The proposed approach would greatly facilitate the coexistence of C-V2X and ITS-G5 at 5.9 GHz, and we would encourage stakeholders to further develop this proposal and come to a speedy agreement on this for the benefit of the European ITS industry as a whole.

Finally, note that the above spectrum sharing solution proposed has been described in the context of the 5875-5905 MHz band. However, depending on the framework adopted for the use of 5.9 GHz also by urban rail ITS, the proposed solution can be adapted and extended to the entirety of the 5875-5925 MHz.

2. Regulatory framework in Europe

The band 5855-5925 MHz is subject to the following harmonisation measures in Europe:

- The European Commission has harmonised the band 5875-5905 MHz for safety-related applications of Intelligent Transport Systems in the European Union via the legally binding Commission Decision 2008/671/EC.
- The same harmonisation is applied by the ECC via ECC Decision (08)01, which additionally indicates that CEPT administrations shall consider within a future review of this Decision the designation of the frequency sub-band 5905-5925 MHz for an extension of ITS spectrum.
- ECC also recommends, via ECC Recommendation (08)01, that CEPT administrations should make the frequency band 5855-5875 MHz available for ITS non-safety applications.

The above regulatory measures all refer to the ETSI Harmonized Standard EN 302 571, which defines requirements for operation of ITS equipment in 5855-5925 MHz, covering the essential requirements of article 3.2 of the Radio Equipment Directive (2014/53/EU). According to ECC DEC (08)01 and ECC REC (08)01, ITS equipment complying with EN 302 571 are exempt from individual licensing for operating in this band.

It should be emphasised that the principle of technology neutrality in the European spectrum regulations implies that any radio technology which can demonstrate conformance with the essential requirements of the Radio Equipment Directive (e.g. through compliance with EN 302 571) can operate in 5855-5925 MHz.

3. Proposed spectrum sharing framework

C-V2X and ITS-G5 use different physical layers and medium access control protocols. As such, the operation of the two technologies in the 5.9 GHz band and in the same geographic area without an agreed coexistence solution would result in mutually harmful co-channel interference.

Such interference can be mitigated in the short term by specifying so-called preferred channels to C-V2X and ITS-G5 in the 5875-5905 MHz band. An example of this is shown in Figure (1) below, where the two technologies are referred to as Technology A and Technology B. In this example, Technology A and Technology B equipment is tuned to operate at 5875-5885 and 5895-5905 MHz, respectively, thereby avoiding any co-channel interference between the two V2X technologies.

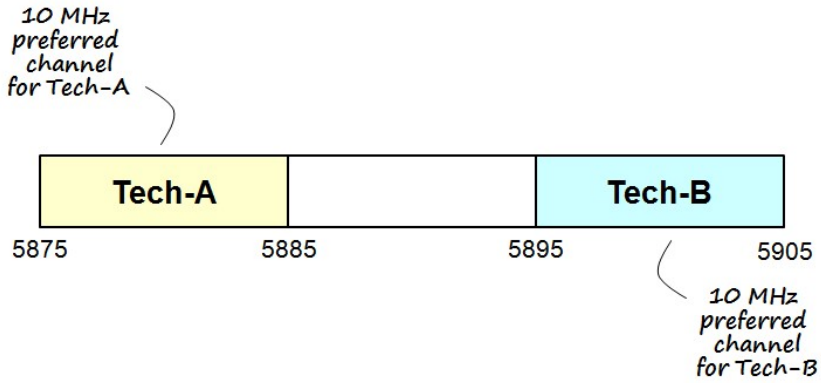

Figure 1. Step-1: Sharing of 5.9 GHz via preferred channels

The spectrum sharing solution proposed above is naturally in line with the fact that the initial industry deployment of any V2X technology in 5875-5905 MHz requires a preselected 10 MHz channel for exchanging safety-related information. As the deployment of the two technologies matures, technical solutions such as mutual detect-and-vacate can be put in place to enable access to the remaining parts of 5875-5905 MHz band and eventually to the entire 5855-5925 MHz band by the two technologies in a fair manner, with a reduced likelihood of harmful co-channel interference.

Figure (2) illustrates an example of such a detect-and-vacate solution for C-V2X and ITS-G5 coexistence at 5.9 GHz. Once again, the two technologies are referred to as Technology A and Technology B. Here, Technology A equipment would operate without any special measures in 5875-5885 MHz. If Technology A equipment wished to transmit in 5885-5895 MHz, then they would need to monitor activity on the relevant channel, and proceed with transmissions if and only if Technology B transmissions are not detected in the said channel. A symmetrical procedure would apply to Technology B. In other words, Technology B equipment would operate without any special measures in 5895-5905 MHz. If Technology B equipment wished to transmit in 5885-5895 MHz, then they would need to monitor activity on the relevant channel, and proceed with transmissions if and only if Technology A transmissions are not detected in the said channel.

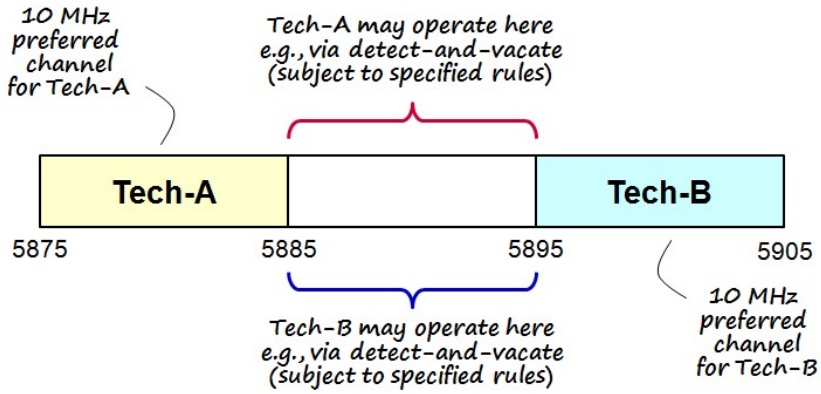

Figure 2. Step-2: Sharing of 5.9 GHz, via preferred channels complemented by mutual detect-and vacate in the middle 10 MHz channel.

Figure (3) illustrates an example of an extended detect-and-vacate solution for C-V2X and ITS-G5 coexistence at 5.9 GHz. Once again, the two technologies are referred to as Technology A and Technology B. Here, Technology A equipment would operate without any special measures in 5875-5885 MHz. If Technology A equipment wished to transmit in 5885-5905 MHz, then they would need to monitor activity on the relevant channel, and proceed with transmissions if and only if Technology B transmissions are not detected in the said channel. A symmetrical procedure would apply to Technology B. In other words, Technology B equipment would operate without any special measures in 5895-5905 MHz. If Technology B equipment wished to transmit in 5875-5895 MHz, then they would need to monitor activity on the relevant channel, and proceed with transmissions if and only if Technology A transmissions are not detected in the said channel.

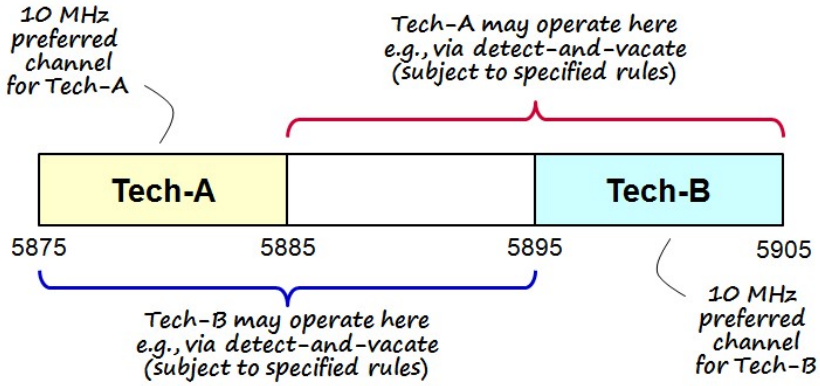

Figure 3. Step-3: Sharing of 5.9 GHz, via preferred channels complemented by mutual detect-and vacate extended to the lower and upper 10 MHz channels.

Once the technology matures, a full sharing of the entire 5855-5925 MHz band can be envisaged.

Suitable sharing mechanisms should be specified in ETSI EN 302 571 on the basis of the results of studies to be undertaken at ETSI, and as captured in a relevant ETSI technical report (TR).

4. Conclusion

It would be greatly beneficial for the ITS industry to rapidly converge on a pragmatic, implementable solution to the issue of co-channel interference at 5.9 GHz between the two leading ITS road technologies, namely C-V2X and ITS-G5.

We emphasize that technology neutral spectrum regulations in Europe means that both technologies can operate at 5.9 GHz subject to compliance with the relevant regulatory technical conditions. It must be emphasized that the proposal does not suggest a regulatory approach toward segmentation of the band. The use of preferred 10 MHz channels by the two technologies is intended to be a short-term solution to be adopted by the industry for the avoidance of mutual harmful co-channel interference. This solution can be complemented in the longer term with a stepwise approach by introducing a dynamic spectrum sharing solution with suitable measures such as mutual detect-and-vacate mechanisms to enable fair access to the whole of 5875-5905 MHz with a reduced risk of harmful co-channel interference.

Specifically, the steps would involve the following:

1) Preferred channels for C-V2X and ITS-G5 (with each of the 5875-5885 and 5895-5905 MHz channels paired with one of either C-V2X or ITS-G5).
2) Shared use of the middle channel (5885-5895 MHz).
3) Shared use of all channels.

We encourage the ITS industry to consider, further develop, and agree on this dynamic spectrum sharing approach, with a view to expedite the successful deployment of C-V2X and ITS-G5 in the 5.9 GHz band.

Finally, note that the above spectrum sharing solution proposed has been described in the context of the 5875-5905 MHz band. However, depending on the framework adopted for the use of 5.9 GHz also by urban rail ITS, the proposed solution can be adapted and extended to the entirety of the 5875-5925 MHz.

Annex A - Change history

Date	Subject/Comment
2017-06	Initial Publication
2018-04	Rev-1 (terminology alignment and general clean-up)

5GAA is a multi-industry association to develop, test and promote communications solutions, initiate their standardization 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 http://5gaa.org/