A petition on the proposal of splitting the 5.9 GHz frequency band

Summary

The deployment of ITS-G5[1] (a.k.a. IEEE 802.11p and pWLAN) has already started and several vehicle manufacturers are in their commercialization phases, where VW has officially announced its launch of pWLAN in 2019. Renault and PSA will equip 1000 vehicles each with 802.11p technology within the pre-deployment project SCOOP@F already at the end of 2017. Further, PSA's and Renault's approach uses two frequency channels out of the three existing ones in the 5.875-5.905 GHz band. In the near term, a split of the frequency band at 5.9 GHz will ruin SCOOP@F. An introduction of LTE-V2X without performing compatibility studies within ECC is against the process of when a new technology wants access to an existing designation with already available services and technologies.

Day one applications using ITS-G5 are launched first but day two applications are just around the corner requiring more frequency channels (e.g., platooning). All vehicle manufacturers need to select an interoperable wireless technology 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 disappears. It is a fact that ITS-G5 and LTE-V2X cannot talk to each other, i.e., they are not interoperable. The usage of two different technologies at 5.9 GHz aiming for the same purpose, where OEMs select differently, will not reduce the number of accidents and incidents on European 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. ITS-G5 is already in place and automotive graded hardware exists.

History

CAR 2 CAR Communication Consortium (C2C-CC), funded in 2002, gathers vehicle manufacturers, suppliers, universities, and research institutes; who are determined that V2X communication can increase road traffic safety significantly. However, to increase road traffic safety by means of V2X requires two ingredients of uttermost importance: (1) a frequency band granting effective protection of road safety applications, and (2) an interoperable communication system between different vehicle manufacturers.

A system reference document (SRDoc) addressing V2X was developed within ETSI[2] and finalized in 2005 (ETSI TR 102 492). It outlines the basic requirements on the frequency band and the communication system to be used for building a V2X system. The SRDoc saw the day of light because of the availability of a wireless technology, namely IEEE 802.11. FCC[3] in the US allocated a 75 MHz band at 5.850-5.925 GHz in 1999, and an amendment to IEEE 802.11 was proposed as a technology for V2X in 2004 and finalized in an official amendment called IEEE 802.11p in 2010. Based on the

[1] ITS-G5 is a European name of IEEE 802.11p and pWLAN. ITS-G5 and IEEE 802.11p will be used interchangeably throughout the paper.
[2] European Telecommunications Standards Institute, EC acknowledged standards development organization
[3] Federal Communications Commission, regulates communications by radio, television, wire, satellite, and cable in the US

findings in the SRDoc, CEPT[4] Report 20 recommended a designation of the 5.855-5.925 GHz frequency band for intelligent transport systems (ITS) in 2007, and in particular the 5.875-5.905 GHz range for critical road safety applications. The following year, the European Commission (EC) issued a commission decision (2008/671/EC) expecting Member States to designate the frequency band 5.875-5.905 GHz based on the findings in CEPT Report 20. Figure 1 outlines a timeline of all documentation for the designation of the 5.9 GHz band.

To create an interoperable communication system between vehicle manufacturers, ETSI Technical Committee on ITS (TC ITS) with 5 working groups was created in December 2007. In October 2009, the European Commission mandated CEN, CENELEC and ETSI with EU-Mandate M/453 to prepare a coherent set of standards, specifications and guidelines to support European Community wide implementation and deployment of Cooperative ITS (C-ITS). The first release of V2X standards was published in 2013 and those are outlined in ETSI TR 101 697. Standards leave room for interpretation and therefore, C2C-CC has developed a basic system profile (BSP) to create a truly interoperable system. C2C-CC has officially announced that C-ITS deployment will commence in 2019 using ITS-G5.

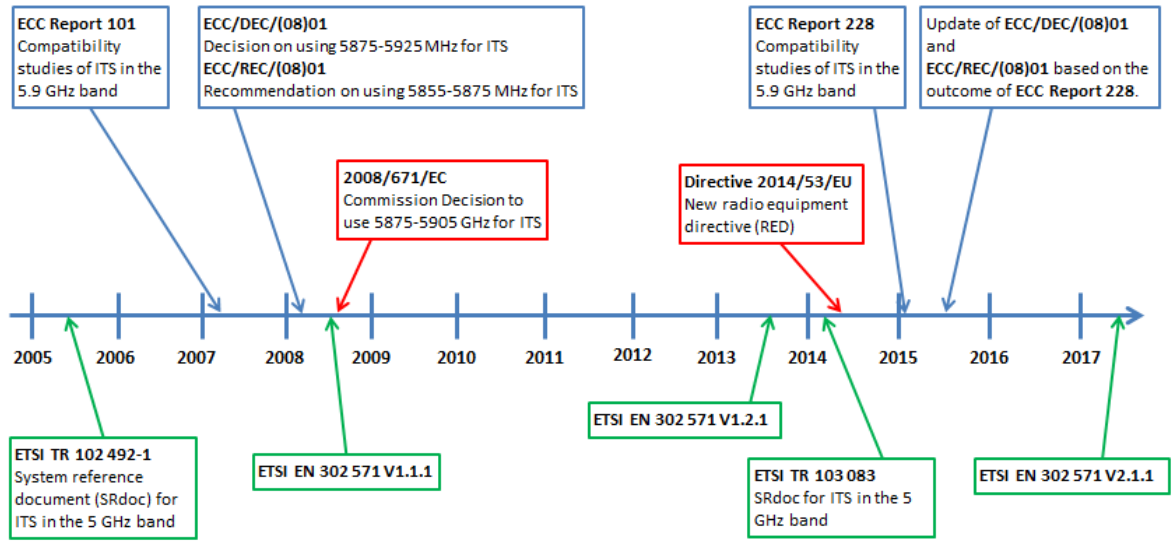

Figure 1. Timeline of all documentation attached to the designation of the 5.9 GHz band.

Why introduce V2X? What are the benefits?

In today's vehicles, there are numerous line-of-sight sensors including radar and cameras, which enable features such as adaptive cruise control (ACC) and lane keeping support. However, these sensors are unable to see beyond physical barriers. They see what the human eye spots but can react much faster to sudden changes compared to a human driver. Furthermore, line-of-sight sensors can detect objects in the immediate vicinity but they have difficulty predicting the intentions of detected objects. The V2X wireless sensor addresses the shortcomings of line-of-sight sensors by charting both location and intention of other vehicles, and it has the ability to see beyond other objects in real-time (with updates provided in a matter of milliseconds). V2X communication closes the gap between long-range cellular technology and line-of-sight sensors by providing information that beats the reaction time of the former and the range of the latter.

[4] European Conference of Postal and Telecommunications Administrations (CEPT) are collecting 48 European countries and their authorities to cooperate around regulation of posts, radio spectrum, and communications networks.

The V2X wireless sensor will in a first step increase the information horizon for the driver by alerting when dangerous situations are impending (day one applications). The next step following close by is to take control of the vehicle when hazardous events are about to happen (day two applications). V2X will increase road traffic safety and thereby, save lives on European roads. The V2X wireless sensor is not only capable of alerting about dangerous situations but also to increase road traffic efficiency through cooperative ACC (CACC) and platooning (road trains of trucks). Platooning has the potential to revolutionize the transportation of goods and at the same time increase safety. The V2X wireless sensor will play an important role for the automated vehicle at large to avoid dangerous situations, increase traffic efficiency but also for short-term and tactical route planning because it can provide intentions of other traffic participants, which none of the other sensors can.

Therefore, to leverage the potential of V2X all vehicle manufacturers need to select interoperable wireless technologies (speak the same language), otherwise, the benefits of increasing safety will diminish.

Why ITS-G5?

When FCC designated a 75 MHz band at 5.9 GHz for ITS in the US in 1999, there were not a single wireless equipment manufacturer that wanted to develop a new wireless technology for the automotive industry. Why? Well, it is very simple; the automotive market is really small compared to for example handheld devices. Last year 1.2 billion new handheld devices (e.g., smartphones, tablets) were put on the market worldwide compared to 90 million new vehicles. In the European Union, 16 million new vehicles were registered last year. The lifetime of a vehicle is also considerably longer (> 10 years) compared to a handheld device that lasts for approximately 2 years. Due to the smaller volumes in automotive, cost for bringing a new technology up to deployment maturity can be substantial.

Due to the abovementioned reasons, OEMs interested in V2X did a tag-along on the WiFi industry and changing the physical layer to accommodate the high-speed vehicular environment was a minor change, not requiring major redesign of radio hardware. Several major EU projects tested and validated IEEE 802.11p early on (e.g., CVIS, SAFESPOT). ITS-G5 is today a well-known technology that fulfills current and future requirements of road traffic safety and efficiency applications. Further, it does not require an operator or a subscription or dependency on network infrastructure.

Why don't we see ITS-G5 equipped vehicles on the streets?

Regardless of wireless technology selected for V2X, there is a penetration problem for road traffic safety applications. What does this imply? When a vehicle manufacturer chooses to add a radar sensor to its vehicles, the customer can see the benefit immediately because a radar is a stand-alone sensor not requiring information from other vehicles.

Increasing traffic safety using the V2X wireless sensor requires that other vehicles are also equipped because traffic safety applications residing in the vehicle are depending on received information from others. Therefore, it will take time before drivers will really see the benefit of having a V2X wireless sensor onboard. To this end, benefits of ITS-G5 from the customer's point of view will grow with increasing market penetration. However, applications residing on smart infrastructure or certain niche applications such as platooning can certainly increase the uptake of V2X.

Road works warning is an application that has gained much attention in deployment projects (e.g., European C-ITS Corridor), where the customer can benefit immediately from warnings sent by construction machinery and roadside units. Green light optimal speed advisory is another application, providing the driver with the next green phase to avoid unnecessary stops at traffic lights (this was successfully showcased during the World Congress on ITS in Bordeaux 2015). Research has shown that if all traffic lights in Germany were providing information about the next green phase, 900 million liters of fuel[5] could be saved and thus a considerable decrease in CO_2 emissions.

The last but not the least reason is the long lifetime of vehicles. Putting a V2X wireless sensor into a vehicle, that needs to function and provide relevant information to the driver for at least a decade requires meticulous planning, development, and integration. A recall of vehicles because of a malfunctioning V2X wireless sensor is for obvious reasons not desirable. As opposed to handheld devices, the automotive industry cannot use its customer to validate the functionality of the vehicle. The sensor also needs to be future proof and work with newer vehicles. New and old vehicles on the roads need to be able to talk to each other; otherwise, the penetration problem will be a recurring dilemma.

The development of a vehicular ad hoc network supporting road traffic safety between different brands across Europe is something really unique. No similar wireless network has never been developed and deployed in the history. Ad hoc networks have a long history in the military industry but then the number of participating network members is known and the wireless technology can be optimized towards that. The shipping and avionic industry are utilizing ad hoc networks for increasing safety (i.e., AIS for ships and VDL mode 4 for airplanes) but those are controlled under international law and the number of network members are limited.

In vehicular ad hoc networks, the communication channel is changing rapidly due to the physical environment and the number of communication partners at any given time is nor controllable neither predictable. The developed system must be able to cope with few vehicles as well as many vehicles (low and very high penetration) without compromising safety. It should work in densely as well as sparsely populated areas.

In summary, the vehicular ad hoc network present challenges that are unique and those have been adequately addressed during the development and standardization of ITS-G5.

Technology neutrality, and spectrum efficiency versus a spectrum split

The European regulatory framework for electronics communications networks and services uses the notion of making regulation technologically neutral (2002/21/EC). This implies that a wireless technology should not be discriminated or favored. However, a designation of a frequency band can put up requirements on a specific service to be operated in the designated frequency band to increase spectrum efficiency. The designation of the 5.9 GHz band (2008/671/EC), states that it should be used for vehicle-to-vehicle and vehicle-to-infrastructure communication to increase road traffic safety. This is an example of making a technology neutral designation. Attached to the designation is a harmonized standard (HS) developed in appropriate working group in ETSI TC ERM, that outlines requirements on the basic radio parameters to be compliant with the Radio Equipment Framework (RED, 2014/53/EU).

[5] https://www.businessgreen.com/bg/news/2333347/audi-gives-green-light-to-fuel-saving-technology

ETSI EN 302 571 is the HS corresponding to 2008/671/EC.A standard is intended to ensure compatibility and interoperability with other products or systems to allow the production of equipment in accordance with the standard. This is, in particular, in line with regulation (EU) No 1025/2012 where the primary goals of standardization are given.

There is a process in Europe when a new designation of a frequency band is foreseen or a new technology wants to enter an existing designation called "European process of standardization and regulation for radiocommunications devices or systems"[6]. It is a process for ensuring an efficient usage of spectrum that has been developed by ETSI and CEPT/ECC[7] in concert, and it is formalized through a Memorandum of Understanding (MoU). This process is followed by everyone and an industry can invoke its interest in a new designation of a frequency band or introducing a new technology in an existing designation by invoking its interest in either CEPT/ECC or in ETSI. This process was followed when the designation of the 5.9 GHz band was performed and for introducing IEEE 802.11p on this band. This was described earlier in current paper under the section "History" (see Figure 1). The process is transparent encouraging all relevant stakeholders to provide input and it has been successfully applied in the past.

When a new technology wants to enter the 5.9 GHz band, this process above applies. The new proposed technology shall undergo a SRDoc development in ETSI and ECC shall perform a compatibility study between existing services and applications in-band as well as out-band. The outcome of the compatibility study is summarized in an ECC report and the findings shall be reflected in corresponding harmonized standard. Since ITS received the designation at 5.9 GHz band in 2008, several other systems also want to use this band or parts of it. These new systems have been through the process of SRDocs, and compatibility studies (ECC reports). These systems are urban rail, broadband radiolinks to ships, and wireless industrial applications.

Within the process described above, Decision 676/EC/2002 also indicates another way of initiating work within CEPT/ECC on spectrum regulation. That is through an EC mandate to CEPT/ECC, which is developed with the assistance of the EU member states in the Radio Spectrum Committee (RSC). The regulation should be drafted with the objective to be applicable beyond EU member states, which makes this process similar to the one described above.

LTE-V2X is a new wireless technology for V2X communication brought forward by 3GPP[8] and it was introduced completely in the latest release of 3GPP specifications (Release 14, June 2017). LTE-V2X (a.k.a. C-V2X) and ITS-G5 cannot co-exist on the same frequency channel (implying that the two technologies will disturb each other). Since the technologies cannot co-exist, 5GAA[9] has proposed that the available 30 MHz at 5.875-5.905 GHz shall be divided between the two technologies, see Figure 2. This proposal is outlined in the 5GAA paper "Coexistence of C-V2X and 802.11p at 5.9 GHz", which has been addressed to DG CONNECT at the European Commission.

[6] See https://cept.org/ecc/ecc-and-etsi
[7] Electronics Communications Committee, https://cept.org/ecc/
[8] The 3rd Generation Partnership Project (3GPP) collects seven telecommunications standard development organizations (ARIB, ATIS, CCSA, ETSI, TSDSI, TTA, TTC), 3GPP develops technical specifications (TS) bundled in releases, 3GPP develops specifications for 4G as well 5G networks despite the name, www.3gpp.org
[9] 5G Automotive Association is a vertical association between vehicle manufacturers and telecom industry for promoting 5G technology, www.5gaa.org

This proposal of dividing the available ITS spectrum, which has not been based on a detailed technical analysis, is contrary to the technology neutrality principle EC is striving for since it is explicitly favoring two technologies. The proposed split is also violating the process established between ECC and ETSI as well as EC and ECC on how to introduce a new wireless technology in an existing frequency designation. LTE-V2X must undergo compatibility studies within ECC and it might be preceded with a SRDoc in ETSI. ITS-G5 is already residing in this band and compatibility studies are a necessity to adequately identify problems and find solutions. 5GAA's proposal of a split of the frequency band is spectrum inefficient, and it is severely limiting day two applications regardless of wireless technology. Furthermore, LTE-V2X is targeting road traffic safety and a compatibility study will reveal if LTE-V2X is robust against interference from other systems in-band as well as out-of-band, which is critical for a technology aiming for saving lives.

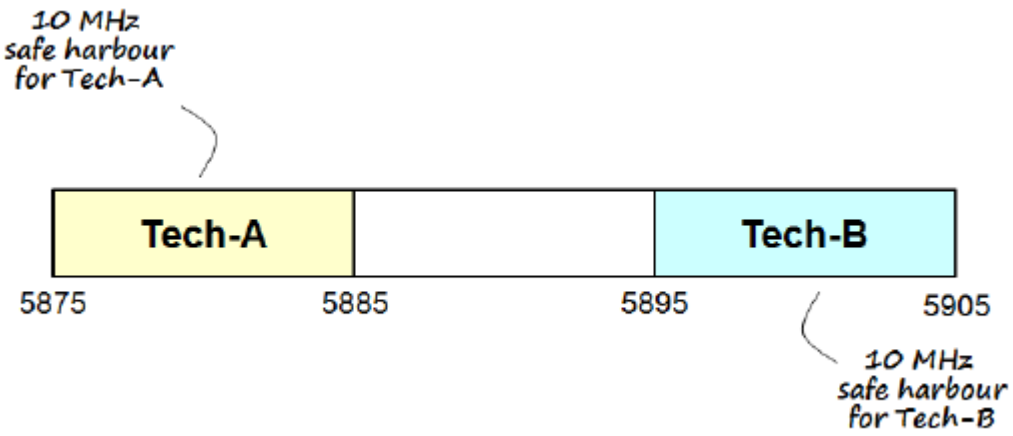

Figure 2. 5GAA proposal to split available spectrum between LTE-V2X and ITS-G5.

Deviating from the principle of technology neutrality of spectrum regulation needs to be justified. This can be a more efficient use of spectrum or the need for interoperability. Any revision of the spectrum regulation for 5.9 GHz should only deviate from technology neutrality, if it enhances interoperability between the existing ITS-G5 system and a new system, e.g., LTE-V2X.

Conclusions

ITS-G5 has already demonstrated its maturity and is in its final phase of deployment in Europe using the frequency band 5.875-5.925 GHz. Delaying its deployment will have impacts on fatal injuries that ITS-G5 is expected to prevent. The new proposed technology by 3GPP called LTE-V2X needs to undergo compatibility studies in ECC to identify potential co-existence and interference issues with already existing wireless technologies residing in-band as well as out-of-band. The proposal of spectrum split also needs to undergo scrutiny.

A spectrum split is: (1) violating the process for introducing a new wireless technology in already designated frequency band, (2) favoring two technologies, (3) blocking new technologies, (4) discriminating any given technology to use all frequency channels, and (5) spectrum inefficient.

A spectrum split is also violating the technology neutrality principal that the EC is aiming for in spectrum regulation. The principle of technology neutrality should only be violated, if it increases spectrum efficiency and enhances interoperability with the existing ITS-G5 system.

The process of compatibility studies in CEPT is a transparent way of identifying strengths and weaknesses of a system and it has been successfully applied in the past. In reality, the proposed spectrum split will not lead to increased road traffic safety since vehicle manufacturers will now hesitate to install V2X at all due to the prevailing circumstances (a delay in market introduction).