Safer and smarter driving: the rollout of Cellular V2X services in Europe

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1. Executive Summary

The GSMA urges the European Commission to adopt a technology-neutral approach in developing the EU's Cooperative Intelligent Transport Systems (C-ITS), notably on safety-related connectivity. It calls upon European legislators to allow the market to decide which technology prevails. This will make Europe's roads safer and smarter, rather than opting for a C-ITS in which ageing 802.11p radio technology would become the *de facto* standard for safety-related connectivity.

Europe's complex C-ITS ecosystem deserves to be built on an optimal technology foundation, in order to remain sustainable over time and maximise the benefits of future investment in 5G.

The more advanced and future-proof Cellular V2X (C-V2X) technology[1] may well save more lives on the roads, as it outperforms 802.11p.[2] The technology has now been standardised and is quickly gaining market traction amongst leading car manufacturers, will be commercially available between six to eighteen months, and is less costly to deploy. Moreover, C-V2X technology will support present and future use cases up to autonomous driving.

Most C-ITS services are supported by currently deployed LTE networks and 23 million cars in Europe are already equipped with LTE modules, for infotainment and emergency call purposes.[3] As car manufacturers already have substantial experience with the uptake of LTE modules, this will ease the rollout of C-ITS services using C-V2X chipsets.

These chipsets are the gateway for the 5G era, in which connected cars are one of the most profound use cases which will revolutionise transport with fully autonomous cars introduced on streets across the globe. In contrast, an isolated, stand-alone 802.11p technology will struggle to evolve with 5G networks and could lead to Europe losing the race for 5G leadership.

Still, the Commission is considering a Delegated Act on C-ITS in order to support 802.11p for safety-related communications, relegating the telecommunications community to focus on other connected car applications and services – in what it calls 'a hybrid communications mix.' This is despite the fact that vehicle manufacturers, and EU Member States, are split over which technology to select for safety-related connectivity – just as a new, forward-looking technology is about to be deployed.

The GSMA is concerned that this proposal would seriously hinder the deployment of C-V2X in Europe, and may lead to a lock-in of an ageing technology that is not future-proof and is put in question by major automotive manufacturers. For safer and smarter roads in the European Union, C-V2X deserves to get full access to the market.

[1] Cellular-V2X is also known as LTE-V2X. For consistency, the GSMA follows the definition of 3GPP.
[2] See section 3.3 for details
[3] In addition to current emergency systems available on a commercial basis, as of March 2018, all new car models in the EU will need to have an on-board embedded cellular module (2G or 3G as per eCall standard) which will trigger automatic calls emergency calls in case of an accident.

2. Introduction

The next few years will be decisive for the introduction of C-ITS in the European Union. After more than a decade of research and development, several EU Member States and road authorities state that they will start deploying initial C-ITS services in 2019. By direct interaction between connected vehicles and the road infrastructure, Europe's road network should become safer, as road users and traffic managers are better able to coordinate their operations.

Within the next two years, the telecommunications industry will bring C-V2X chipsets and services to market, following the finalisation of 3GPP standards earlier this year. C-V2X will be the foundation of cutting edge mobile technology in next-generation vehicles – cars and trucks alike. C-V2X is not just important for the coming introduction of C-ITS but will be especially relevant for the 5G era, in which the deployment of fully autonomous, self-driving, vehicles is expected and state-of-the-art vehicle communications are needed.

The GSMA is concerned that Europe's rollout plans of C-ITS do not take into account the very high potential of C-V2X. The GSMA notes that the European Commission wishes to prevent a fragmented deployment of two different vehicle-to-vehicle communications. It therefore clearly favours the 'incumbent' technology, 802.11p, that forms the radio standard within the C-ITS framework called ITS-G5. The Commission is considering whether to announce a European Delegated Act on C-ITS soon, which would mean that by 2019 any future technology on the market would need to be able to communicate with cars deployed with 802.11p technology over their entire lifetime. This would, effectively, lock-in 802.11p as the central communications V2X technology for decades.

In this briefing paper, the GSMA explains the key features of C-V2X, also comparing the technology with 802.11p. This is followed by an update on testing and deployment of C-V2X services. A brief overview of international policy developments on C-ITS is provided before describing the likely consequences of a delegated act on C-ITS. In the conclusions, the GSMA advocates for a guiding set of principles and discusses next steps.

3. Key features of C-V2X and 802.11p

3.1 Introduction of C-V2X

3GPP has developed the LTE standard to support new services to meet the requirements and needs of the automotive industry for advanced vehicular communications.

Work related to V2X (Vehicle-to-Everything) started in 2014 when 3GPP *Release 13* (February 2015) resulted in feasibility studies on potential requirements and modifications needed to support existing specifications for V2X communications. These were implemented in 3GPP *Release 14* (completed in June 2017) which includes full support for Cellular V2X (C-V2X) services. The specifications describe two models of communication: mobile network assisted and direct communication.[4]

The LTE module in the vehicle can utilise both models at the same time. Vehicles can communicate directly to warn each other about events and potential incidents, while at the same time they can receive useful network-based information about traffic congestion without competing for resources (e.g. spectrum).

The table below lists some of the main use cases that are supported by Cellular V2X in 3GPP *Release 14*[5]:

Vehicle-to-Vehicle (V2V) Use Cases	**Vehicle-to-Infrastructure (V2I) & Vehicle-to-Network (V2N) Use Cases**	**Vehicle-to-Person (V2P) Use Cases**
Emergency vehicle warning	Emergency stop	Collision warning
Emergency stop	Queue warning	Pedestrian road safety
Control loss warning	Curve Speed warning	Vulnerable road user safety
Pre-crash sensing warning	Road safety services	
Forward collision warning	Road user monitoring	
Cooperative adaptive cruise control	Remote diagnosis	
Wrong way driving warning	Traffic flow optimisation	

3.2 Introduction of IEEE 802.11p

[4] **Mobile network assisted:** a vehicle is able to connect to the mobile network through the traditional LTE Uu interface. In addition, utilising the mobile network allows to coordinate also the direct communication, by means of resource assignment. This mode requires network coverage.
Direct communication: a vehicle can communicate to another entity (vehicle, road-side unit or a vulnerable road user) without needing the support of a mobile network via the PC5 interface. This model can be used also where there is no network coverage and it can be used with or without a SIM (no subscription to an operator is needed).
[5] all day 1 services can be fulfilled, plus also day 1.5 from: C-ITS Platform, final report January2016 (https://ec.europa.eu/transport/sites/transport/files/themes/its/doc/c-its-platform-final-report-january-2016.pdf)

In 2004, the IEEE embarked on standardising a new version in the 802.11 family to add Wireless Access In Vehicular Environments (WAVE), thus creating a software stack that utilised 802.11p. This system was finalised into IEEE 802.11 in 2012 and designed to operate in the 5.9 GHz band.[6] It is the building block for different sets of standards for V2X. In the United States and in Europe the development of V2X communication developed in parallel, and it led to the creation of Dedicated Short Range Communication (DSRC) in the U.S. and ITS-G5 in Europe, which constitute two different profiles of 802.11p.

Currently C-ITS mainly supports V2V and V2I communication. V2P communications – to connect with other devices, like smartphones or tablets - is potentially possible by installing extra software (e.g. an applet) in the device and modifying the firmware, but this is not ideal.

3.3 Comparison of C-V2X and 802.11p

The biggest advantage of C-V2X is the ability to have use all the features provided by the existing LTE network, which supports all existing and future C-ITS use cases. 3GPP is already working in the next evolution of C-V2X, where it will be able to tackle the more enhanced safety use cases, resulting in higher throughput, higher reliability, more precise positioning and lower latency. Thanks to the 3GPP ecosystem, the evolution path of C-V2X is much more promising than that of 802.11p and will result in an even wider gap between the two technologies. C-V2X is able to offer a native solution that can be used on a wide variety of devices, including smartphones, thus allowing pedestrians, cyclists and other vulnerable road users and drivers of any legacy vehicle to realise the true safety benefits of ITS.

Recent studies indicated that C-V2X has a better performance than 802.11p in respect to coverage, providing a minimum of 56% performance increase as demonstrated in a recent study.[7] LTE has higher spectral efficiency, which will allow to serve higher number of road users at a given spectrum. In addition, LTE offers higher level security compared to 802.11p.[8]

One major drawback for 802.11p is that it is not future proof. It will certainly not offer the potential to be forward compatible with a future 5G based C-ITS systems generations, as being planned in 5GAA, 5GCAR and other groups. This means that OEM will be forced to support an increasing multitude of technologies and consequently an increase complexity of the system, integration, testing and overall costs.

By the end of 2017, an estimated 23 million cars in Europe will be equipped with an LTE (4G) chipset, for instance for infotainment and emergency services[9] (Machina Research figures). This number is expected to rise to 258 million cars by 2025 – which means that virtually all (new) cars driving around in Europe by then will have LTE technology built in.

[6] ITS-G5 only defines the radio part of the ITS system and it operates in three different bands (from 5855-5925 MHz): ITS-G5A, ITS-G5B and ITS-G5C . For supporting ITS systems ETSI has introduction on top of ITS-G5 several layers that can still be used in collaboration with C-V2X.
[7] "Cellular V2X as the Essential Enabler of Superior Global Connected Transportation Services" http://5g.ieee.org/tech-focus/june-2017/cellular-v2x
[8] "The Case for Cellular V2X for Safety and Cooperative Driving - 5GAA" http://5gaa.org/pdfs/5GAA-whitepaper-23-Nov-2016.pdf
[9] In addition to current emergency systems available on a commercial basis, as of March 2018, all new car models in the EU will need to have an on-board embedded cellular module (2G or 3G as per eCall standard) which will trigger automatic calls emergency calls in case of an accident.

These numbers will be hard to beat for 802.11p, which has hardly been integrated into cars until now, mainly in the framework of collaborative projects funded by the European Commission.

Moreover, the deployment of 802.11p will require a greenfield infrastructure deployment, making the business case for V2I communications profoundly difficult. This is a major reason why the technology has been lying 'on the shelf' in the United States for fifteen years, without any major deployment being planned. Road operators such as those in Spain are also complaining about the high costs of operation and maintenance of the road networks. By contrast, even if there is a need to deploy road side units, cellular V2X leverages existing widespread LTE infrastructure. This would enable rapid rollouts at scale across Europe.

In short, the main advantages of C-V2X are:

- C-V2X is a **future proof technology** that has been developed with the intrinsic mobility support, quality of service, high number of devices, optimisation of resources.

- C-V2X will be an **integral part of 5G** allowing the full range of automotive services to be enabled and consequently bring huge benefits for safety (not only for the passengers but also for pedestrians) and traffic management.

- C-V2X has proven to provide **higher performance for capacity, coverage, range, scalability, number of devices supported and security.**[10]

- Utilising the full spectrum of C-V2X service (V2V, V2I, V2P, V2N) and support end-to-end applications **reduce the total cost of ownership**, thanks to already available infrastructure.[11]

- **Car manufacturers have substantial experience with cellular technologies** and will easily make the step to integrating C-V2X chipsets into their cars. The cellular installed base in vehicles is already counting around 210 million vehicles, globally, of which 81 million are 4G with an average estimated growth of 30% per year (according to Machina Research).

[10] See note 8.
[11] See page 46 of the 2014 report *Study on the Deployment of C-ITS in Europe* (European Commission). The report concluded that using cellular networks to provide V2I services can have immediate benefits. "The 'high' sensitivity considered in the [cost-benefit analysis] evaluated the impact of using the cellular network to provide V2I services, rather than dedicated roadside infrastructure – thereby achieving a very high infrastructure penetration across all roads from day 1." According to one scenario of the study, there could be annual net benefits in 2030 increasing by over €5 billion to €17.3 billion.

4. Deployment of C-V2X services

4.1 Availability of chipsets

3GPP finalised the specification work for supporting C-V2X communication in June 2017. The organisation is developing the associated standards for testing and interoperability, which are expected to be finalised by June 2018. In the meantime, all main chip manufacturers are actively developing prototypes based on C-V2X.

3GPP Release 15 will further enhance V2X to support additional services (e.g. automated cooperative driving), provide further network optimisation and introduce support for V2X within 5G. This demonstrates a reliable evolution path of mobile technology, with forward compatibility in order to support the increasing demand for new services and stringent performance requirements.

Testing timetable

The equipment conformity testing for V2V are set to be completed in September 2017. Work on other aspects of V2X, beyond V2V, will be completed by June 2018. Such test specifications are then utilised by certification bodies which will define the test suites and perform the certification of the vehicle module.

The certification process depends on the specific certification bodies. Generally, the modules that are commercially available are verified and certified within individual mobile operators and then obtain certification from one or more of the certification bodies.

The process for testing chipsets and modules is well established and manufacturers will benefit from the experience and scale of deploying other mobile devices. The GSMA does not expect any obstacles to the introduction of new modules to the market.

As one of the founders of the European Automotive and Telecoms Alliance (EATA), the GSMA supports the establishment of pre-deployment projects in which key features of connected and automated driving are being tested – in real-life situations on European roads. This is the right environment for rigorous testing of the C-V2X chipsets, once they are available, and also compare coexistence of 802.11p technology in the 5.9 GHz band. The European Commission has granted 10 million euros in co-funding for the Concorda project, in which use cases as highway chauffeur driving will be tested in Member States across the EU. It is expected that these tests will commence in 2018.

4.2 Commercialisation of C-V2X

There are two aspects to consider regarding the commercialisation of C-V2X services: the modules and the network.

The time taken to produce commercial modules depends on several factors, such as whether hardware modification of the chipset is required; whether a new radio interface is created; whether it only involves a software upgrade; and the actual demand. For the case of V2V support, there are no major changes considered in the chipset and module other than to support the ITS bands mentioned. In general *Release 14* can be seen as an enhancement of the already defined Proximity-based services from 3GPP *Releases 12 and 13*. Potentially, modules could become available from 12-18 months after the publication of the standard (thus around Q2-Q4 2018), depending on the actual demand. Chipset and module

manufacturers will test the functionality with their partner mobile operators, before making the device commercially available.

On the network side, direct communications between vehicles and road-side infrastructures needs no operator support at all, and can be deployed immediately as soon as approved V2X modules become available. The actual deployment of the service in operators' network is not a given, since the feature might not have been commercially deployed yet. However, LTE networks already deployed can basically support all use cases mentioned in the table above, and mobile operators are able to upgrade their LTE infrastructure quite rapidly to support new cellular V2X features.

Mobile telecom operators have an interest in deploying C-V2X services, despite the fact that a substantial part of the communications (i.e. V2V) will not go over cellular networks. In essence, the C-V2X chipset is the gateway for cutting-edge telecoms equipment into connected vehicles – and in the long run, self-driving vehicles. In this revolutionary change, an entire new market for vehicle connectivity services will emerge, of which V2V applications will form an important piece.

There is also potential for operators to provide Business-to-Business services using C-V2X, such as services to motorway operators, by connecting the infrastructure and providing analytics. C-V2X will also use the standard cellular link via the base station (called LTE-Uu) for some (future) ITS use cases in addition to the PC5 Interface.

4.3 International policy developments

Policy makers across the world are developing C-ITS ecosystems and preparing legislation, as the technology for cooperative driving evolves and connected and autonomous vehicles are being introduced into the market.

The United States was the first country to support ITS by making the 5.9 GHz band available around the turn of the century. However, since then period little progress has been made. One vehicle manufacturer has started installing the 802.11p technology into a limited set of vehicles, but the key challenge remains the technology and business case for vehicle-to-infrastructure build-outs.

In April 2017, the US Department of Transportation received several hundred comments – and a significant portion of them were negative – to its Notice of Proposed Rulemaking (NPRM) which would mandate DSRC (based on 802.11p technology) on vehicles for 10 MHz of V2V communication. It is uncertain whether there will be a DSRC mandate in the United States; it seems like greater flexibility will be given to the market to mature.

On the other side of the world, the Chinese government is decidedly going to mandate C-V2X for C-ITS and safety-related services. Spectrum has already been put aside for a trial of the technology in six cities. This is an important development as the automotive industry prefers to work with a minimum of difference of standards worldwide, and the Chinese vehicle market will become the biggest in the world.

See Annex I for an overview of international policy developments.

5. Consequences of C-ITS regulation for the deployment of C-V2X services in the European Union

5.1 EU roadmap for introducing C-ITS

In recent years, the European Union and the Member States have put significant effort into the development of C-ITS in Europe. In 2008 the EU reserved the 5.9 GHz band for safety-related C-ITS applications, and the Commission made millions of euros in funding available to study the feasibility of C-ITS services.

The members of the C-ITS Platform, which did not include any mobile network operators, laid the groundwork for the '*European strategy on C-ITS, a milestone towards cooperative, connected and automated mobility'* report, which was published in November 2016. The strategy was put together in order to avoid a fragmented C-ITS market and create synergies between different initiatives. Policy topics addressed in the strategy include cybersecurity, data protection and interoperability.

The Commission wishes to move ahead as quickly as possible, not only because technologies for C-ITS are available but also because road safety in Europe is not improving. After years of falling fatality numbers, the amount of lives lost in road accidents in the EU has levelled out, at around 26,000 a year. Notably the Commission has committed to halving road deaths between 2010 and 2020 (to around 16,000).

This is why 2019 will be an important year for C-ITS in Europe. At the end of the current Commission mandate, safer roads should be one of the main successes. This requires not only the instalment of C-ITS technology in cars, but also in large-scale investments in road infrastructure. Hence the C-Roads platform was created which comprises EU Member States and their road operators are unified, in order to begin deploying C-ITS services in Europe by 2019.

5.2 Impact of Delegated Act for C-ITS

With the publication of the '*Inception Impact Assessment on specifications for the provision of cooperative intelligent transport systems'* report in May 2017, a Delegated Act may be adopted next year, in order to be effective from 1 January 2019. The Commission is taking this step because it foresees a slow and fragmented deployment of C-ITS without changes in the legal framework.

On the issue of communication technologies, the Commission has already stated that it wishes to 'ensure a forward-looking hybrid communication approach' as stipulated in the 2016 EU strategy on C-ITS. This may result in legally binding specifications for C-ITS communications, possibly including demands for interoperability and backwards compatibility.

The hybrid mix of communication technologies can be interpreted as a model in which the coexistence of both 802.11p and C-V2X systems is guaranteed. But the GSMA understands that the Commission's current view of a hybrid mix the hybrid mix actually entails a *task division* in which ITS-G5 (i.e. 802.11p) technologies deal with the safety related C-ITS messages, whereas the cellular technologies focus on other connected car services. In other words, the Commission apparently wants the car-to-car communications to be run over 802.11p systems and avoid use of LTE V2V systems.

Such an approach would lead to a lock-in of one specific technology for vehicle-to-vehicle and vehicle-to-infrastructure communications. If the regulator stipulates any requirements for interoperability or backwards compatibility with the current standard of the ITS-G5 framework – meaning 802.11p technology – that will result into a *de facto* mandate. C-V2X and 802.11p are not interoperable – not now and not in the future. The systems do not send out the same radio layer messages, their structure is fundamentally different, and they will have different performance characteristics, with C-V2X having a longer range that 802.11p. This in turn may lead to further incompatibilities, as C-V2X reception will happen before 802.11p reception.

With vehicle-to-vehicle communications being at the heart of the connected vehicles ecosystem, any hindrance for C-V2X chipsets to be used for this service will constitute a market barrier. Competition questions aside, such a move by the Commission does not align well with its own 5G Action Plan, adopted in September 2016, in which connected cars are a major use case for 5G networks. In this Action Plan, as well as in the proposed Electronic Communications Code, the EU calls on the telecoms industry to invest heavily in Europe's next-generation communications networks to maintain the continent's leading role in the global race for connectivity. But over time, fully automated driving will be in a 5G environment, and not in an 802.11p world. C-V2X is the bridge towards 5G, yet the Commission may well put it as a disadvantage in a Delegated Act.

Of course, a (de facto) mandate for a specific technology will reduce fragmentation. It will however put Europe on the wrong side of progress. Vehicle manufacturers are – even internally in some cases – divided on which technology to use. The Car 2 Car Communications Consortium propagates 802.11p, while the new 5GAA considers C-V2X to be "the leading and superior technology" for car communications. Interference of the Commission into the market will not take away these divisions; it is the wrong way to address fragmentation as the market currently is developing at high speed.

A further important consideration to keep in mind is that, for C-ITS to actually result in a reduction of road fatalities, the system needs to be used in a critical mass of vehicles. Given the very slow introduction of 802.11p in car models and the only recent standardisation of C-V2X, C-ITS will only start showing results in a decade. European new car registrations are in the vicinity of 12-13 million vehicles per year. On average 5% of the vehicle stock is upgraded every year, which means full replacement of Europe's car fleet takes at least twenty years. In that sense, the Commission should not seek to 'pick a winner' for the safety-related communications – as we expect C-V2X to become the worldwide standard within a few years.

6. Conclusions and next steps

Policymakers and regulators in a number of markets are looking to accelerate the deployment of safety oriented vehicle-to-vehicle communications. Whatever direction the debate on C-ITS in Europe is taking, the development of an ecosystem for safer and smarter driving will not be easy. A multitude of stakeholders are involved, large (public) investments are needed and technology is evolving rapidly.

The GSMA calls upon European legislators to keep future decisions on the vehicle-to-vehicle communications **technology neutral.** Connected vehicles and C-ITS solutions are nurtured in a fast-evolving technology environment. This industry ecosystem is best-placed to identify a solution that is sustainable, scalable and future proof. No regional standard should be set in isolation or given an undue advantage above another. Given the short timeframe of the deployment of C-V2X chipsets and services, it would be counterproductive to *de facto* mandate 802.11p as the selected technology for V2V services.

While safety is paramount to all and should be a key primary objective of policy intervention, it is important to consider all other policy objectives of the Commission's own Connected Cooperative and Automated Mobility (CCAM) strategy, including reduction of congestion and pollution. While vehicle-to-vehicle applications predominantly focus on car to car safety applications, C-V2X will be able to cover all goals of CCAM. C-V2X is interoperable with widespread, existing infrastructure and network applications and is thus better positioned than 802.11p to **achieve other policy objectives that are more heavily based on wide area network connectivity**, which include mapping, smart parking, car sharing applications. C-V2X and in the future 5G are also expected to lead to better results regarding car safety, especially in demanding traffic situations involving multiple cars, where scalability of the technology is an essential requirement.

There is an ongoing discussion within the automotive industry on the **coexistence of V2V technologies in the 5.9 GHz band**. The 5GAA has published a position paper on the matter that should be fully considered. In this context, it is important to emphasise that any coexistence measures would be an interim solution, aiming to facilitate a period of thorough testing and benchmarking of the two communication systems against each other. In the longer term, the GSMA expects one technology to provide C-ITS services in Europe and use the full range of the 5.9 GHz band. As a principle, it should be up to the market to make this decision.

A growing number of prominent car manufacturers have come to the conclusion that C-V2X is superior to 802.11p technology. Global developments are also shifting towards C-V2X especially with the quickly growing Chinese car market opting for C-V2X instead of 802.11p. Critical mass is crucial for safety related vehicle-to-vehicle technologies to deliver expected results. **C-V2X has the potential for rapid market penetration** as it not only enables vehicle-to-vehicle services, but a wider suite of vehicle-to-network solutions and services, from travel management to mapping and infotainment, making it an economically sustainable choice for car manufacturers. The integration of C-V2X technology in smart phones will highly contribute to efficiently increase the penetration rate of ITS services.

Apart from the technology aspects related to the direct communication between vehicles, two thirds of ITS Day 1 use case are based on V2I communication, which can be realised immediately using cellular networks (2G, 3G and 4G). Subsets of these have already been

implemented by various car OEMs as part of their own connected car platforms utilising today's cellular networks.

For testing, field trials and pre-deployment pilots, the GSMA supports the projects of the European Automotive and Telecoms Alliance (EATA) – of which the GSMA and many of its (Associate) Members are active participants – which can serve as the rigorous testing ground needed.

There is no quick way to make Europe's road infrastructure safer. But C-V2X is the best shot: it is a future-proof technology which will give a higher performance for capacity, coverage, range scalability and security. It will be cheaper to deploy and car manufacturers already are knowledgeable about integrating cellular technology. For safer and smarter roads, C-V2X is the way forward.

Annex I

Overview of global C-ITS policies

While there is no dominant technological approach to safety related ITS as yet, it is evident that spectrum in the 5.9 GHz range is central to most efforts internationally. As stated in the main text, it is uncertain whether there will be a technology mandate in the United States. China is going to mandate C-V2X technology, which will have a profound impact on the automotive market.

On a wider international level, ITS and spectrum in the 5.9 GHz band will be discussed at the World Radiocommunication Conference in November 2019. Agenda Item 1.12 will focus on spectrum provisions for ITS in the 5.9 GHz band, and Agenda Item 1.16 will address calls to extend the ability of RLAN (e.g. Wi-Fi) to access 5GHz spectrum including the range being considered by many countries for ITS.

The following table explains important aspects regarding global policies on C-ITS, notably on spectrum allocation.

Australia	- 5850-5925 MHz is set aside for C-ITS and specifically 802.11p - but this will be reviewed once the C-V2X standard in 3GPP is completed
China	- There is no spectrum designation for safety related ITS. Discussions on-going for 5875-5925 MHz to be made available for ITS on a non-exclusive basis. - C-V2X technology will be mandated in China and in 2016, 5905-5925 MHz was allocated for C-V2X trial projects in 6 major cities
EU	- 5875-5905 MHz has been designated for safety related ITS on a technology neutral basis with co-existence measures being considered currently
Japan	- 755.5-764.5 MHz is available on an exclusive and licence exempt basis. The 5.8 GHz band is being studied for V2V and V2I safety related communications. - In Q4-2015 Toyota started shipping ARIB STD-T109 equipment (which is somewhat based on 802.11-2007) in vehicles in Japan - Road side unit deployments in fewer than 30 junctions in Q4-2015
South Korea	- In 2016, South Korea assigned 5855-5925 MHz for V2V and V2I communications
United States	- 5850-5925 MHz has been available for ITS on a non-exclusive and licensed basis for over 16 years. The focus is on the WAVE/802.11p system and a band plan has been created with specific channels for safety. - There are a number of trials, but no significant commercial deployments, with the V2I build-out proving a challenge for the auto industry - Unclear if the approach will change with the new administration and ongoing regulatory proceedings - The government is considering a mandated 802.11p in new cars by 2021-2022, with the prognosis unclear and even slightly negative, given the current US political climate - GM has incorporated 802.11p in the Cadillac ATS beginning in model year 2017

WRC-19	There will be two relevant Agenda Items (AI) at WRC-19 which will have implications for ITS systems; and the spectrum being considered for ITS in 5.9 GHz as there is some interest in including this range as an option for a wider 5GHz unlicensed band principally to support Wi-Fi: 1. AI 1.12: to consider possible global or regional harmonized frequency bands, to the maximum extent possible, for the implementation of evolving Intelligent Transport Systems (ITS) under existing mobile-service allocations, in accordance with Resolution 237 (WRC-15) 2. AI 1.16: to consider issues related to wireless access systems, including radio local area networks (WAS/RLAN), in the frequency bands between 5 150 MHz and 5 925 MHz, and take the appropriate regulatory actions, including additional spectrum allocations to the mobile service, in accordance with Resolution 239 (WRC-15)

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