January 25, 2019

BY ELECTRONIC SUBMISSION

National Highway Traffic Safety Administration
1200 New Jersey Ave., S.E.
W12-140
Washington, DC 20590
ATTN: Finch Fulton, Deputy Assistant Secretary for Transportation Policy

Re: *V2X Communications (Docket No. DOT-OST-2018-0210)*

Dear Deputy Assistant Secretary Fulton

I, T. Russell Shields, respectfully submit these comments in response to the Department of Transportation (DOT) Notice *Request for Comments: V2X Communications.* This response, based on my 20 years of experience in communications for vehicle safety, is my personal opinion and does not reflect the position of any organization.

Regarding my experience in the communications industry, I was a founder of the organization that became the Cellular Telecommunications and Internet Association (CTIA). I served as the first President of the Automotive Multimedia Interface Collaboration (AMI-C), which helped vehicle manufacturers reach common external interface specifications for in-vehicle multimedia. I served two terms as Chair of the Committee on Communications of the Transportation Research Board (National Research Council). I was Convenor of the international working group developing standards for vehicle-vehicle and vehicle-infrastructure communications (ISO/TC204/WG16). I am now Chair of the Collaboration on ITS Communication Standards of the ITU, the UN specialized agency for information and communications technology (ICT). I am also ITU representative to the World Forum for Harmonization of Vehicle Regulations.

Likewise, I have been involved in the ITS industry from its beginnings. I was a founding officer and director of ITS America. I was a founder of the ITS World Congress and am a member of its board of directors. In 1996, I was General Chair of the first ITS World Congress held in the United States. I chaired or served on multiple committees of the Society of Automotive Engineers (SAE). I received the 1998 SAE-Delco Electronics Intelligent Transportation Systems Award for distinguished service to the ITS industry. In 2007, I was named an SAE Fellow. I was inducted into the inaugural class of ITS America's ITS Hall of Fame in 2008. And in 2010, I was named the inaugural U.S. member of the ITS World Congress Hall of Fame. I am a member of the National Space-Based Positioning, Navigation and Timing Advisory Board, a U.S. Presidential advisory committee.

Together with Paul Najarian, currently in the U.S. Department of State International Communication and Information Policy (CIP) group, I led the effort 20 years ago to get the 5.9 GHz allocation for vehicle communications.

We chose to use IEEE 802.11a as the basis of a bearer protocol to allow testing of safety applications in 5.9 GHz because it was the only short-range OFDM TDD standard in 1998. It was well known at that time that the test protocol to be developed was never appropriate for production use.

We chose sending a “Here I Am” message as a test application for making sure that the test protocol worked well enough for safety application testing. It was well known that the test application was a poor one since receiving warning that another vehicle was around would just be distracting to drivers and have no safety value.

1. Please provide information on what existing or future technologies could be used for V2X communications, including, but not limited to, DSRC, LTE C-V2X and 5G New Radio. What are the advantages and disadvantages of each technology? What is the timeframe for deployment of technologies not yet in production? Please provide data supporting your position.

DSRC means “dedicated short-range communications.” IEEE 802.11p is one DSRC bearer protocol. Deploying IEEE 802.11p in 5.9 GHz will destroy the band for useful V2X communications. IEEE 802.11p is a slightly hacked version of IEEE 802.11a, which can be thought of as Wi-Fi 2. IEEE 802.11n is Wi-Fi 4, IEEE 802.11ac is Wi-Fi 5, and IEEE 802.11ax is now Wi-Fi 6. This simple timeline indicates that the IEEE standards have left IEEE 802.11a far behind. As a kludged version of IEEE 802.11a, IEEE 802.11p is ancient technology.

C-V2X (3GPP Release 14) is another DSRC bearer protocol. C-V2X is integrated into mainstream cellular technology. The Release 14 version of C-V2X is a direct-capability replacement of IEEE 802.11p with current communications capabilities. 3GPP Release 16 is planned to have the V2X capabilities to support automated driving needs such as merging into a crowded expressway.

3GPP releases are upward compatible if the physical radio has adequate memory and processing power. U.S. DOT (NHTSA) should require that C-V2X implementations have the capabilities to be updated over the air to at least two future 3GPP releases.

C-V2X has been extensively tested and is ready for production roll-outs in passenger vehicles in the U.S. 5GAA has extensively proven the superiority of C-V2X over 802.11p in characteristics such as range, reliability, and latency. More important is that C-V2X has an upgrade path as part of mainstream cellular while IEEE 802.11p is not part of mainstream Wi-Fi.

2. Of the V2X communications technologies previously discussed, at present only DSRC is permitted to be used in the 5.9 GHz spectrum band for transportation applications. If that allocation were to be changed to allow any communication technology for transportation applications, could DSRC and other technologies (e.g., C-V2X, 5G or any future technology) operate in the same spectrum band or even the same channel without interference? Why or why not? If there are any technical challenges to achieving this goal, what are they and how can they be overcome?

There is no reasonable way for IEEE 802.11p and C-V2X to operate in the same channel, since IEEE 802.11p has a “listen before you talk” channel access scheme in contrast to the C-V2X time and frequency slot reservation scheme.

Although IEEE 802.11p and C-V2X devices could exist on separate channels in the ITS band, the IEEE 802.11p “deployments” are relatively small scale while market forces point toward the future nearly 100% deployment of LTE in new vehicles such that there will be massive deployment of C-V2X, which will require exclusive use the ITS band.

3. To what extent is it technically feasible for multiple V2X communications technologies and protocols to be interoperable with one another? Why or why not? Can this be done in a way that meets the performance requirements for safety of life applications, as they were discussed in the V2V NPRM? What additional equipment would be needed to achieve interoperability or changes in standards and specifications? What is the projected cost of any necessary changes? How soon can these changes and equipment prototypes be available for testing?

There is no reasonable way for IEEE 802.11p and C-V2X to operate together in the same band. It is technically possible if there is channel separation with good ACLR but much spectrum would be lost. They cannot simultaneously transmit in the same communications channel without destructive interference.

4. To what extent is it technically feasible for different generations of the same V2X communications technologies and protocols to be interoperable with one another? Why or why not? Can this be done in a way that meets the performance requirements for safety of life applications? What additional equipment or changes in standards and specifications would be needed to achieve interoperability? What is the projected cost of any necessary changes?

There is no reasonable way for IEEE 802.11p and C-V2X to operate together in the same band. It is technically possible if there is channel separation with good ACLR but much spectrum would be lost. They cannot simultaneously transmit in the same communications channel without destructive interference.

5. Even if they are interoperable across different technologies and generations of the same technology, would there be advantages if a single communications protocol were to be used for V2V safety communications? What about other V2X safety applications, such as those involving V2I and V2P communications?

V2V, V2I, and V2P will all be more robust and practical using C-V2X. IEEE 802.11p is unlikely to be added to mobile phones.

6. How would the development of alternative communication technologies affect other V2I and V2P communications, such as those supporting mobility or environmental applications? Do these applications have the same or different interoperability issues as V2V safety communications? Do different V2X applications (e.g., platooning) have different communication needs, particularly latency?

3GPP Release 16 should meet the known needs of all V2X applications.

7. Do different communication technologies present different issues concerning physical security (i.e., how to integrate alternative communication technologies into vehicle systems), message security (i.e., SCMS design or other approaches), or other issues such as cybersecurity or privacy? Would these concerns be affected if multiple but still interoperable communication technologies are used rather than one?

There is no practical way to have reliable cybersecurity for IEEE 802.11p except by using an additional cellular radio.

C-V2X has cybersecurity built in. Note that when using ITS spectrum without a SIM card, there must be a way to authenticate the sender. Hence, some PKI might be needed.

8. How could communications technologies (DSRC, C-V2X, 5G or some other technology) be leveraged to support current and emerging automated vehicle applications? Will different communication technologies be used in different ways? How?

3GPP Release 16 requirements cover all likely highly automated driving and safety applications for at least the next decade.

3GPP releases are upward compatible if the physical radio has adequate memory and processing power. U.S. DOT (NHTSA) should require that C-V2X implementations have the hardware capacity to be updated over the air to at least two future 3GPP releases.

9. How could deployments, both existing and planned, assess communications needs and determine which technologies are most appropriate and whether and how interoperability could be achieved?

Use a wide set of communications experts in the assessments. The communications expertise is found in ATIS in the U.S. and in 3GPP and ITU internationally.

Additional Note.

Emergency services in the U.S. are moving to a consistent cellular approach using cellular through the First Responder Network Authority (FirstNet) under congressional mandate.

In the future, all police vehicles, fire trucks, and ambulances will be equipped with cellular. Over time, this will include C-V2X for applications such as emergency vehicle signal preemption. It seems strange that buses, passenger vehicles, and delivery trucks would use a different communications protocol that would require infrastructure such as traffic signals to have two different radios instead of just having different frequencies.

Installing an IEEE 802.11p device would be redundant since connectivity to the core network plus long range communication will use C-V2X features in the future.

Respectfully submitted

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