DEPARTMENT OF TRANSPORTATION

Office of the Secretary

Docket No. DOT-OST-2018-0210

Request for Comments: V2X Communications

Comments of Cisco Systems, Inc.

Cisco Systems, Inc. (Cisco) is pleased to provide comments on the above-captioned docket seeking information on V2X technologies. Cisco is a leading provider of IP-based technologies, solutions and services. Cisco is a San Jose, California based Fortune 100 firm with a global presence, and counts among its customers a significant number of transportation interests of all types. Pertinent to this docket, Cisco offers Connected Roadway solutions to various transportation authorities, such as state Departments of Transportation.[1] Connected Roadways is a solution set that, among other things, includes 5.9 GHz V2X radios authorized under the Commission's rules for Dedicated Short Range Communications (DSRC). In addition, Cisco authored a reference architecture that highway authorities could use to think about how roadside units, and the data flowing through them, could be integrated into the enterprise's IP networks, including other technologies those agencies may wish to utilize along roads. Our customers are deploying Connected Roadway solutions to obtain the data necessary to innovate across a range of safety and efficiency goals. Below, Cisco offers its responses to the questions raised in the Request for Comment.

[1] https://www.cisco.com/c/en/us/solutions/industries/transportation/connected-roadways.html

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 – This technology, in our view, is mature and rapidly gaining acceptance in the market. Cisco includes DSRC in its suite of solutions that is sold under the umbrella solution of "Connected Roadways" and our experience is that highway authorities, such as state departments of transportation, are very interested in deploying DSRC, and a growing number have either done so or have deployed the networks preparatory to radio deployment. On the standards side, IEEE 802.11 has formed a task group (TG 802.11bd) charged with evolving the existing 802.11p standard. The working group has united around a goal of a seamless evolution path, focusing on the need for next generation technology to coexist with the prior generation of radio technology and to interoperate it. As a result, technology to be promulgated under 802.11bd will be backward compatible with existing DSRC. Customers seeking to deploy DSRC today, therefore, can do so confident that their technology purchases will not be rendered obsolete when the next generation of DSRC is built.

LTE C-V2X – Cisco has not participated in the standards process. We have read and commented on the 5GAA Petition for Waiver at the Federal Communications Commission, which is the most detailed statement to date on the development of C-V2X. We understand that this is a 4G technology, and that China has recently approved 5905-5925 MHz for C-V2X use.

5G New Radio: Cisco has not participated in the standards process.

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?

The 3GPP technologies have not been designed to interoperate with, or to coexist with DSRC. It is for this reason that 5GAA is currently before the FCC asking for 20 MHz of spectrum for the exclusive use of C-V2X. The underlying technology platforms are quite different. DSRC is built on an 802.11 platform that utilizes contention-based protocols to share spectrum between radios. C-V2X is built on a 3GPP LTE platform requiring precise control of the timing of transmissions to allow spectrum to be shared. For this reason, co-channel operation is not recommended.

To address the lack of coexistence and interoperability, the 5GAA organization has suggested subdividing the band so that DSRC and C-V2X could operate in a manner independent of each other. If there is a desire to set aside some of the 5.9 GHz band for C-V2X, then regulators will need to understand, and resolve, the impact of C-V2X on adjacent DSRC transmissions, and DSRC transmissions on adjacent C-V2X. From the 5GAA Waiver Petition, we see no evidence that the impact of C-V2X on adjacent DSRC transmissions has been evaluated.

While we do not prejudge the outcome of such an evaluation, we do wish to point out that radio signals are not tidy, and sharper "shoulders" of a radio emission are possible only with more expensive filtering. Such filtering could affect the final cost of the radio.

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?

Interoperability is best achieved at the "phy" or physical layer of the radio. DSRC, like Wi-Fi, operates on a contention-based protocol. DSRC co-channel and adjacent channel operation has been specified only for like modulations, not for dissimilar modulations.

For dissimilar modulations (such as C-V2X), the implementations of DSRC would have to be tested to determine co- channel and adjacent channel operation. That said, as the 5GAA waiver makes clear, a 10 or 20 MHz wide C-V2X signal would interfere with DSRC co-channel and, unless testing proves otherwise, would interfere with DSRC adjacent channel. There is no simple "cure" for the lack of interoperability, and there is no "addition of equipment" that would allow these two systems to interoperate.

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?

Different generations of the same technology can be more easily made to interoperate, if developers of subsequent generations choose to do so. In the case of 802.11bd, which is the successor to 802.11p, developers have committed that the new technology will be able to read the headers in transmissions from 802.11p, recognize this as the earlier generation, and to communicate on the basis of 10 MHz channels whenever 802.11p is present. In this way, the new generation can interoperate at the radio level with the former generation. As more of the new generation radios ultimate find their way to deployment, the new generation will be able to communicate more often using the new generation standard, raising the effectiveness of all. Please note that interoperability and backward compatibility is an affirmative choice that developers make to ensure that the new version of technology can be seamlessly introduced to the market. If the choice is not made, one cannot assume that a new generation of technology would, in fact, be interoperable and backward compatible.

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?

A single protocol is always the most efficient. However, a single protocol does not allow technology to evolve. Therefore, the public policy is best served if new generations or new technologies are interoperable and backward compatible with the first generation.

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?

Different applications do have different latency requirements. Designing an interoperable alternative communication technology can address the needs of expected applications, including latency requirements.

If interoperability is not a consideration in the design of an alternative technology, then as a technical matter it might be possible for non-latency sensitive applications to interoperate at the applications level. An example might be a warning to the vehicle of road work ahead. But Cisco cautions that latency sensitive applications – safety, platooning, or even pedestrian warning – are likely to be negatively impacted if interoperability happens at the application layer.

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?

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?

Low-latency or peer-to-peer application (such as safety or platooning) should be supported by technologies that are interoperable at the physical radio layer. Other

applications (such as a warning of a danger ahead on the roadway) could be supported by a different technology in theory. Using different technologies for different applications, however, means vehicles will need both technologies on board, and it is possible that would be true of infrastructure as well.

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?

As Cisco has previously advised, equipping the road system and vehicles with connectivity for safety is a classic example of network effects. The radio systems deployed must be the same or interoperable for the network to achieve its maximum benefits. If there is an assessment and choice of non-interoperable technology by state or by automotive OEM, then the maximum benefits will not be obtained.

Respectfully submitted,

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