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For the best of reasons

January 24, 2019

Docket Management Facility
U.S. Department of Transportation
1200 New Jersey Avenue SE
West Building Ground Floor, Room W12-140
Washington, DC 20590-0001

Subject: Response to Request for Comments on Docket No. DOT-OST-2018-0210: V2X Communications

Noblis is pleased to provide the following response to the United States Department of Transportation's (USDOT's) Request for Comments on Docket No. DOT-OST-2018-0210: V2X Communications. Noblis has been providing Intelligent Transportation Systems (ITS) technical support services to the USDOT since 1991 and believes that vehicle-to-everything (V2X) communications plays an important role in the future of transportation. We stand ready to continue helping the USDOT and ITS stakeholder community continue to advance ITS technologies into the future.

Sincerely,

Karl Wunderlich
Director, Surface Transportation Systems
Noblis

United States Department of Transportation

Office of the Secretary (OST)

[Docket No. DOT-OST-2018-0210]

Response to Request for Comments:
V2X Communications

24 January 2019

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1 Introduction

Dedicated Short Range Communications (DSRC) is a set of technologies and associated standards enabling vehicle-to-everything (V2X) communications. A competing set of standards and technologies based on two forms of advanced cellular technology [LTE (as defined in 3GPP Release 14) and the 5G New Radio (NR) (will be defined in a 3GPP future release)] are both being developed for various forms of Cellular Vehicle-to-Everything (C-V2X) applications. In a nutshell, DSRC standards and pilot deployments are relatively mature compared to C-V2X but require new investment in roadside infrastructure. C-V2X is relatively less mature than DSRC in terms of standards development and deployment experience. C-V2X holds the promise of a rapid, lower-cost national rollout leveraging existing cellular telecom infrastructure where cell sites are suitably located close to roadway infrastructure for certain applications and use cases, however there may be carrier subscriptions and recurring costs associated with some of those use cases. While there are strengths and weaknesses to both DSRC and C-V2X approaches, ultimately, it will be the market composed of automobile manufacturers, device vendors, and state and local deployment agencies that will determine how these technologies are used and deployed.

V2X communications are required to enable connectivity among vehicles, mobile devices, and infrastructure-based control systems. Low-cost, ubiquitous V2X connectivity and vehicle autonomy are the two fundamental technologies transforming the next generation of ITS and surface mobility. DSRC and C-V2X are two competing, mutually exclusive (that is, non-interoperable) visions of how to utilize the 5.9 GHz spectrum currently set aside by the FCC in the ITS Radio Service for ITS applications. At this time, it is not clear which approach will prevail in the market – or even if one vision alone will eventually dominate the market for V2X connectivity. While the market matures, one proposed approach is to facilitate a level-playing field competition between the two approaches. The downside to this approach is the deployment of two incompatible technologies which may create mutually exclusive islands of interoperability.

2 Competitive Deployments

The fundamental feature of competitive deployments is facilitating fair, side-by-side (non-interfering) testing of the two competing approaches, allowing the market to make an unbiased, informed assessment of the relative technical and business case merits for each technology and use case. The ability for both DSRC and C-V2X to co-exist will be driven by how the existing spectrum allocated for V2X applications is either partitioned or shared (5.9 GHz) and the lower layer communications protocols that each technology employs to minimize channel conflicts and congestion. There are multiple solutions under consideration and both DSRC and C-V2X have their own mechanisms for mitigating channel conflicts and congestion. In this paper, Noblis offers an overview of some of these proposed solutions for DSRC and C-V2X co-existence and some of the issues that might be encountered implementing them. A more detailed, comprehensive and unbiased analysis is needed to determine the advantages and disadvantages of each proposed solution to better inform the overall ITS community and key decision makers.

Why Co-Existence is Important

Interoperable communications between vehicles and infrastructure is necessary to achieve the benefits provided by V2V safety applications. Additionally, state and local agencies will want to ensure their vehicle-to-infrastructure (V2I) infrastructure is able to communicate with the largest possible population of connected devices. DSRC and C-V2X based devices are not expected to be interoperable (e.g., a DSRC radio is not expected to be able to communicate with a C-V2X radio). Since these devices will not be able to communicate with each other directly, it is important strategies are put in place to ensure that they minimize contention and conflicts between each other. Additionally, each communications technology has specific advantages and disadvantages that may make one or the other better for certain use cases.

IEEE 802.11, LTE, and 5G NR are technologies being considered by the Federal Communications Commission (FCC) – as well as radio regulatory agencies in other countries – to be allowed to use parts of the 5 GHz band on an unlicensed basis for any application. There are a multitude of complex issues being addressed by several Standards Development Organizations (SDOs) that would affect V2X communications plans. The following are some of the solutions being considered and possible impacts that could result from implementing these solutions

Different implementation options, which will be detailed in the following section, have their own benefits and weaknesses both for interoperability and for operation impacts on current and near future deployments.

Sharing Channels

DSRC and C-V2X sharing the same channels could be an option; however, the feasibility of channel sharing will be determined by the lower level protocols employed within both technologies. Each technology operating as a licensed ITS Radio Service technology would have to reliably sense the channels in use and fairly share available channels. These issues have been the main topic of discussion by the IEEE Coexistence Standing Committee, which meets every two months at the IEEE 802 Wireless Standards meetings. This committee has extensively studied the idea of IEEE 802.11 technology (e.g., DSRC) sharing spectrum with a LTE-based technology (e.g., C-V2X) with both being unlicensed. The use of Energy Detection (ED) versus modifying 3GPP standards to enable Preamble Detection (PD), which is more accurate in determining if the spectrum is in use, has not been resolved. Neither have the issues with Listen-Before-Talk (LBT) intervals and spectrum reservation mechanisms in LTE to ensure fair access to the channel. These same issues would apply if both DSRC (based on either IEEE 802.11p or IEEE 802.11bd) and LTE operated in the same channels as a licensed service. If both technologies share channels, sense activity, and defer transmissions if the channel is busy, there may be significant performance degradation issues. It should be noted that the current congestion control algorithms specified for DSRC in the safety of life channel (172) may not work for two incompatible technologies. If this option is pursued, these issues will require careful evaluation and assessment.

Several liaison letters have been exchanged between IEEE and 3GPP concerning Wi-Fi sharing with LTE, and issues relating to spectrum use sensing and fair access to the channel have not been resolved.[1]

Two additional issues in evaluating the feasibility of this option lie in the fact that neither DSRC or LTE are planned for long term use. IEEE 802.11 has initiated the IEEE 802.11bd Task Group to write a new standard to update DSRC with enhanced performance, new features, and to accommodate future applications. Similarly, the 3GPP is developing standards in a future Release 16 to use the planned 5G New Radio (NR) for the same objectives. Since both technologies are being developed, and concepts are evolving, they represent a moving target in terms of performing technical assessments and evaluations.

Partitioning Channels

Partitioning channels, by designating certain 5.9 GHz channels as either DSRC-only or C-V2X-only, is another potential option; however, which channels get allocated to which technology could have drastic impacts on current deployments of DSRC technology and DSRC devices themselves depending on how vendors have implemented channel specifications in their devices. This also can lead to mutually exclusive islands of interoperability for each technology. These types of changes would create a ripple effect that impacts multiple ITS standards and could result in the obsolescence of current V2X equipment.

The 5GAA has submitted a waiver[2] to reserve 5.9 GHz channels 182 and 184 for C-V2X usage Channel 184 is designated in the FCC rules as a high-power channel for use by Public Safety Agencies (which includes first responders, State and Local Government, State DOTs and Public Transit). Both the New York City DOT (NYCDOT) and Tampa-Hillsborough Expressway Authority (THEA) are currently utilizing channel 182 for some of their V2I applications. There are other DSRC deployments that may be utilizing channels 182 and 184 as well. Additionally, any currently deployed DSRC device, whether they are currently using channels 182/184 or not, will still be capable of using channels 182 and 184 and would be a potential source of interference in the future.

There is also the possibility of adjacent channel and alternate adjacent interference between DSRC and C-V2X on channels 178,180, 182 and 184. In this case this would only affect those channels; however, this is a potential issue in any scenario where DSRC and C-V2X share adjacent channels. The level of interference is dependent on the technology being used, the transmit power level, and the geometry between affected devices. This is an area where more extensive RF analysis and simulation is needed to determine the extent of any issues and what possible solutions may exist.

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[1] Document 802.11-18/2118r1 available at:
https://mentor.ieee.org/802.11/documents?is_dcn=DCN%2C%20Title%2C%20Author%20or%20Affiliation&is_group=coex

[2] https://ecfsapi.fcc.gov/file/11212224101742/5GAA%20Petition%20for%20Waiver%20-%20Final%2011.21.2018.pdf

Allowing Unlicensed Devices to Operate in the 5.9 GHz ITS Radio Service Band

In the ongoing proceeding, “Unlicensed National Information Infrastructure (U-NII) Devices in the 5 GHz Band”, ET Docket No. 13-49, the FCC is investigating opening the 5.9 GHz ITS Radio Service allocation to unlicensed devices, which includes IEEE 802.11, IEEE 802.15, LTE technologies and devices with proprietary protocols such as baby monitors and garage door openers. This proposal is likely to produce interference issues for anyone that would operate in the 5.9 GHz band, including DSRC and C-V2X. The THEA CV Pilot program has already encountered interference issues with a HamWAN radio network when they were deploying DSRC equipped Roadside Units (RSUs) and vehicles equipped with Onboard Units (OBUs). A HamWAN network in Tampa was a secondary licensee on the 5.9 GHz band, and broadcast in the channel 180 and 184 channel ranges. Their technology does not support channel sensing and sharing protocols, and the THEA CV Pilot program saw upload time and throughput degraded by 50% when the HamWAN network was operating. Unless every unlicensed technology supported channel sensing and sharing features, this would likely be repeated on a more wide spread scale.

3 Conclusion

Noblis believes V2X communications technology is important to the future of surface transportation. However, there are various technologies and implementation strategies; each with unique performance and economic considerations. The ITS community needs an unbiased and independent assessment of the many potential solutions – objective and comprehensive analyses that can better inform ITS program managers, policy makers, system integrators, and the general user community. This type of assessment would help the United States Department of Transportation (USDOT) substantiate vendor/provider claims of new technologies and solutions. It would allow the USDOT to answer questions such as:

- Can this technology perform as claimed/implied?
- Can it do so in an operational ITS environment?
- Can it do so for the cost suggested?
- What happens as the technology evolves? Would it support backward/forward compatibility?
- Does the commercial market suggest the technology will scale, or survive?
- What are the risks (cost, technical, schedule) associated with adopting the technology?
- Are there viable alternatives? What are they?

Technology Assessment Methodology

A holistic understanding of new communications technologies and services would involve more comprehensive technology assessment methodology which would include:

- **Discovery:** Discovery would involve the collection of information and data regarding a technology, or class of technologies, that might meet general stakeholder requirements – in this case, communications technologies or commercial communications service offerings for V2V and V2I applications. In addition to a comprehensive look at technology, the discovery phase can also be used to identify state-of-the-practice (e.g., how/where these types of technology are currently used within the ITS domain).

- **Assessment:** Assessment involves various levels of study, simulation and analysis, all scoped to a level of depth depending on the specific technical issue being assessed. Assessments would usually fall into one of the following categories:
    - **Paper Assessment:** This involves a detailed and objective study of the technology, service, or class of technologies/services, in question, assessing the information found through discovery, and verifying vendor/provider claims of performance, capability, cost, etc. This study often includes an *alternative technologies assessment*, where various technologies that might meet stakeholder requirements are identified and compared (e.g., DSRC evolution vs. C-V2X 5G). The level of assessment could range from a simple white paper to a detailed and comprehensive analysis.
    - **Use-Case Assessment:** These studies would be used to identify how the technologies or services might best apply to various ITS applications. They would consider application requirements, implementation plans (schedule and location), the tech/service performance characteristics, availability, costs/budget, program risks (budget, technical, schedule) and other program metrics.
    - **Modeling and Simulation:** These are used to better understand the performance of a technology or service in particular environments (variable service parameters, variable operational environments, etc.). For communication technologies and services this might include network modeling and simulation as well as RF analyses.
- **Field Study (Pilot):** While modeling and simulation offer a higher lever confidence in performance, field studies proved a much better understanding of performance in a true operational environment, particularly for wireless technologies, which can be difficult to accurately model.

One candidate for this type of technology assessment would be to assess some of the advanced networking concepts for C-V2X. C-V2X may support non-Line of Sight (non-LOS) use cases. The architecture of traditional cellular networks support a mix of services such as voice, messaging, and data. The backbone networks of the C-V2X era will likely need to accommodate several vertical applications (e.g. C-V2X, traditional cellular use) through the support of distinct network slices on software defined and programmable infrastructure. These network slices would be collections of virtual network functions and associated parameter configurations that are implemented on top a physical network. Specific slices would be tailored to a service such as C-V2X for low latency and high bandwidth. This would only be possible through using Software Defined Network (SDN) and Network Function Virtualization (NFV).

The technology assessment methodology above could be used to explore different proposals for these advanced networking concepts. With the proper equipment and expertise an evaluation using virtual infrastructure along with an SDN could be used to assess different network slicing concepts and develop adoption strategies for the future backbone networks. These assessments could also model how SDNs and NFVs can be used to define the network slice with rigorous Quality of Service (QoS) levels and deterministic bandwidth to meet C-V2X mission critical requirements.

USDOT requires candid, unbiased, objective, and independent analysis to evaluate V2X technologies. Noblis has been a provider of this type of analysis for many years and stands ready to continue helping USDOT with this type of support into the future.