

the cost of other competing vehicle-to-everything technologies.² Consequently, C-V2X technology potentially will save taxpayer money that otherwise would be used to deploy, maintain, and upgrade roadside units utilized by non-cellular technologies. C-V2X has the advantage of a higher spectrum efficiency and supports larger ranges compared to non-cellular technologies.³ In addition, with support from the entire cellular ecosystem, C-V2X is incorporated into the latest cellular standards with a planned upgrade path for enhanced safety features. Subsequent versions of C-V2X may offer the potential for future safety enhancements as 5G technologies are developed and deployed. Moreover, C-V2X's use of already available and deployed commercial cellular networks potentially offer added safety features that are not available with other technologies. In light of these benefits, 5GAA urges the FHWA to consider further how it can leverage the benefits of C-V2X and synergies between commercial mobile networks and the development of connected transportation safety services.

I. THE 5G AUTOMOTIVE ASSOCIATION

5GAA⁴ is a relatively new global cross-industry association of companies from the automotive, technology and telecommunications industries who share the common goal of improving road safety. Created in September 2016, 5GAA's mission is to accelerate the global deployment of intelligent transport and communications solutions. In pursuing this mission, 5GAA aims to address society's connected mobility and transportation safety needs.

To accomplish this mission, 5GAA is actively taking steps to develop, test, and promote communications solutions, initiate their standardization, and accelerate their commercial availability and

² Tom Rebbeck et al., *Final Report For 5GAA: Socio-Economic Benefits of Cellular V2X*, at 7, Analysys Mason (Dec. 2017) ("Socio-Economic Benefits of Cellular V2X"), http://5gaa.org/wp-content/uploads/2017/12/Final-report-for-5GAA-on-cellular-V2X-socio-economic-benefits-051217_FINAL.pdf

³ See 5GAA, *An assessment of LTE-V2X (PC5) and 802.11p direct communications technologies for improved road safety in the EU*, <http://5gaa.org/wp-content/uploads/2017/12/5GAA-Road-safety-FINAL2017-12-05.pdf>.

⁴ <http://5gaa.org>.

global market penetration. The intelligent applications being pursued by 5GAA include safety and mobility services. These applications encompass automated driving and would be integrated into all our nation's roads and particularly with smart cities.

Since its inception by eight founding companies, 5GAA has experienced a dramatic increase in membership. Today, 5GAA has over 75 member companies, including leading automotive manufacturers,⁵ chipset/communication system providers,⁶ mobile network operators,⁷ and infrastructure vendors.⁸ The diversity of 5GAA's membership base, both in term of geographical spread and expertise, makes it uniquely situated to comment on the issues raised in the ADS RFI.

II. THE FHWA SHOULD CONSIDER HOW TO FACILITATE THE DEPLOYMENT OF V2X INFRASTRUCTURE AND NETWORKS

As the FHWA assesses the infrastructure requirements for ADS, 5GAA urges it to also consider how it can facilitate the deployment of infrastructure and networks supporting vehicle-to-everything (“V2X”) technologies, and in particular, cellular V2X (“C-V2X”). V2X technologies will help improve road safety, advance travel efficiency, and complement automated driving.

In general, V2X directly connects vehicles to everything—including to each other (“V2V”), to pedestrians (“V2P”), to roadway infrastructure (“V2I”), and to the network (“V2N”).⁹ Collectively, these communications will redefine transportation by providing real-time, highly reliable, and actionable information flows to drivers and their vehicles. For example, V2V services can alert drivers of slow or stationary vehicles out of the line-of-sight, while V2P services can alert drivers to the location of

⁵ *E.g.*, Ford Motor Company, BMW, and Daimler.

⁶ *E.g.*, Ericsson, Intel, Qualcomm, and Samsung, among others.

⁷ *E.g.*, AT&T and Verizon, among others.

⁸ *E.g.*, Nokia, Samsung, and Panasonic, among others.

⁹ *See* 5GAA, Explore The Technology: V2X, <http://5gaa.org/5g-technology/c-v2x/> (last visited Feb. 23, 2018) (describing V2X technology).

pedestrians out of the line-of-sight. Likewise, V2I services may allow for vehicles to communicate with connected roadside infrastructure, such as a connected traffic signal.¹⁰ And V2N services may allow for delivery of information over communications networks, including weather conditions, traffic information, and smart routing.

The services and applications offered by V2X may help dramatically improve vehicle safety. According to the National Highway Traffic Safety Administration (“NHTSA”), 37,461 lives were lost on U.S. roads in 2016.¹¹ This roughly equates to a fatality rate of 1.18 deaths per 100 million vehicle miles traveled.¹² By enabling and facilitating the flow of information between vehicles, pedestrians and road infrastructure, V2X will enable connected vehicles to anticipate and avoid dangerous situations, reducing collisions and saving lives. NHTSA estimates that if V2V alone were fully deployed across the U.S. vehicle fleet it could prevent approximately 400,000 to 600,000 crashes, 190,000 to 270,000 injuries, and save 780 to 1,080 lives each year.¹³ The addition of other V2X capabilities would further enhance these V2V safety applications, saving even more lives.

V2X will also improve travel efficiency. V2X will enable vehicles to travel safely in dense traffic situations and support new, automation solutions such as truck platooning. These applications and services will not only save U.S. drivers time, they will also enable energy cost savings and reduce the need to expand the public highways to support increased traffic flows.¹⁴

¹⁰ V2V, V2P, and some V2I communications can be sent peer to peer, meaning that there is no need for an operator subscription or cellular coverage for delivery of these communications.

¹¹ See Press Release, NHTSA, *USDOT Releases 2016 Fatal Traffic Crash Data* (Oct. 6, 2017), <https://www.nhtsa.gov/press-releases/usdot-releases-2016-fatal-traffic-crash-data>.

¹² See *id.*

¹³ NHTSA, *NHTSA Issues Advance Notice of Proposed Rulemaking and Research Report on Ground-Breaking Crash Avoidance Technology: “Vehicle-to-Vehicle Communications: Readiness of V2V Technology for Application”*, at 2 (Feb. 23, 2015), https://www.nhtsa.gov/sites/nhtsa.dot.gov/files/documents/v2v_fact_sheet_101414_v2a.pdf.

¹⁴ See FHWA, *FHWA Truck Platooning Facts*, https://www.fhwa.dot.gov/research/truck_platooning/fhwa_truck_platooning_facts.pdf.

And V2X will complement ADS. V2X has distinct capabilities that can be used in combination with automated vehicle technologies (e.g., sensors, radar and cameras). For example, C-V2X can extend an automated vehicle’s ability to “see” further down the road by providing 360-degree non line-of-sight awareness.¹⁵ This capability complements the use of sensors, which rely on line-of-sight and good weather conditions, limiting their range and capabilities under certain conditions.

Likewise, utilizing V2X in conjunction with automated vehicle technologies provides a higher level of predictability than sensors, radar, and cameras alone. V2X allows vehicles to communicate their intent (e.g., sudden lane changes) and share sensor data between vehicles, including sharing information with trailing vehicles even if the horizon may be obstructed.¹⁶ Similarly, V2X offers enhanced situational awareness by providing soft safety alerts and graduated warnings to nearby vehicles.¹⁷ The sharing of these types of information will help vehicles better anticipate and react to the movements of other nearby vehicles.

The path to fully automated vehicles will require coexistence for a period of time between vehicles with no active control systems and varying levels of automated vehicles, including fully automated vehicles. V2X technology will help enable this coexistence by ensuring that both fully automated vehicles and drivers of other levels of automated vehicles maintain complete awareness of nearby vehicles and other roadway hazards. C-V2X technology is well positioned to implement the full slate of V2X benefits listed above.

¹⁵ Socio-Economic Benefits of Cellular V2X, at 15; *see also* Qualcomm, Cellular V2X: Overview (“Qualcomm V2X Overview”), <https://www.qualcomm.com/invention/technologies/lte/advanced-pro/cellular-v2x> (last visited Feb. 23, 2018).

¹⁶ Qualcomm V2X Overview.

¹⁷ *Id.*

III. C-V2X POTENTIALLY OFFERS A HOST OF BENEFITS

Up until recently, dedicated short range communication systems (“DSRC”), based on an early variant of Wi-Fi that was developed in the late 1990s, was the only communications technology thought capable of supporting vehicle communication based crash avoidance.¹⁸ However, in June 2017, the Third Generation Partnership,¹⁹ an entity comprised of global telecommunications standards development organizations, developed a standard for V2X based on cellular LTE.²⁰ The development of this standard is a potential game changer for the viability of C-V2X to support vehicle communication-based crash avoidance.²¹ Consequently, a number of 5GAA’s member companies have announced joint testing of C-V2X to demonstrate the safety benefits of this technology.²²

Notably, C-V2X offers a number of distinct advantages for widespread deployment. First, C-V2X can leverage existing and future investments in commercial mobile cellular networks—ultimately saving taxpayers money. Second, C-V2X offers the potential for future safety enhancements as 5G technologies are developed and deployed. In fact, future enhancements to C-V2X already are being planned for future 3GPP releases. Third, C-V2X’s use of the commercial cellular network potentially offers added safety features on America’s roadways.

¹⁸ See Federal Motor Vehicle Safety Standards; V2V Communications, 82 Fed. Reg. 3854, 3864 (Jan. 12, 2017) (“At this time, DSRC is the only mature communication option that meets the latency requirements to support vehicle communication based crash avoidance, although future V2V standards may also meet the latency requirements.”).

¹⁹ The 3rd Generation Partnership Project (“3GPP”) unites seven global telecommunications standard development organizations and covers cellular telecommunications network technologies, including radio access, the core transport network, and service capabilities and thus provides complete system specifications.

²⁰ See 3GPP, Release 14, <http://www.3gpp.org/release-14> (last visited Feb. 23, 2018).

²¹ As defined in 3GPP Release 14, C-V2X provides for the exchange of messaging and data utilizing cellular-based LTE technology between vehicles, between vehicles and pedestrians, between vehicles and infrastructure, and between vehicles and cellular networks. C-V2X will use the same message protocols as DSRC to provide software programming codes, definitions, and formats needed create interoperable, consistent, and seamless communications exchange among shared information systems and devices. Thus, adoption of C-V2X will leverage the research and testing of DSRC and remain compatible with established safety and traffic information applications.

²² Press Release, Qualcomm, AT&T, Ford, Nokia and Qualcomm Launch Cellular-V2X Connected Car Technology Trials Planned for the San Diego Regional Proving Ground with Support From McCain (Oct. 31, 2017), <https://www.qualcomm.com/news/releases/2017/10/31/att-ford-nokia-and-qualcomm-launch-cellular-v2x-connected-car-technology>.

In light of these benefits, 5GAA urges the FHWA to consider further how it can leverage the potential benefits of C-V2X along with synergies between commercial mobile networks and the development of connected transportation safety services.

A. *C-V2X's Ability to Utilize Commercial Mobile Network Infrastructure Offers Potential Cost Savings to Taxpayers—FHWA Should Explore Policies that Identify Similar Synergies Between Cellular Networks and ADS Infrastructure*

One of the key potential benefits of C-V2X lies in its ability to leverage existing and future private sector investments in commercial wireless networks. Accordingly, 5GAA encourages the FHWA to explore ways in which it can identify and pursue similar synergies between commercial cellular networks and ADS infrastructure.

The wireless industry historically has borne the cost of commercial mobile network deployments, maintenance, and upgrades. Indeed, wireless carriers and infrastructure providers have invested nearly \$489 billion since the advent of commercial mobile networks.²³ More recently, network investments by the wireless industry include \$200 billion in network investments between 2010 and 2017, and \$26.4 billion in 2016 alone.²⁴ By the end of 2016, the wireless industry estimates that there were 308,334 cell sites in the United States, a number that likely has grown as a result of network densification efforts by wireless carriers.²⁵

Moreover, network investment is predicted to grow. According to one estimate, the wireless industry is expected to invest as much as \$275 billion in mobile networks between 2017 and 2024.²⁶ Leveraging these private sector investments could yield considerable cost savings to taxpayers—who

²³ CTIA, *Wireless Snapshot 2017*, at 4 (May 2017), <https://www.ctia.org/docs/default-source/default-document-library/ctia-wireless-snapshot.pdf>.

²⁴ *Id.* at 5.

²⁵ *Id.* at 3.

²⁶ Accenture Strategy, *Smart Cities: How 5G Can Help Municipalities Become Vibrant Smart Cities*, at 3 (2017), <https://www.ctia.org/docs/default-source/default-document-library/how-5g-can-help-municipalities-become-vibrant-smart-cities-accenture.pdf>.

otherwise likely will be responsible for the costs of deploying, maintaining, and upgrading publicly-owned V2X network infrastructure that utilizes non-cellular technologies.

The FHWA also should consider how it might create additional synergies between the deployment of C-V2X-capable mobile networks and ADS infrastructure improvements. In particular, the FHWA should consider whether improvements in surface transportation infrastructure create opportunities to expand C-V2X-capable networks in areas that may otherwise be traditionally uneconomic for commercial wireless providers to service. Similarly, the FHWA should consider how it might leverage the evolution of C-V2X-capable networks to support and advance vehicle automation. For example, the FHWA might be able to develop policies that facilitate partnerships between commercial mobile network operators and road operators through programs administered by the FHWA. By taking such proactive measures, the FHWA can help to facilitate advancement of C-V2X-capable networks and ADS technologies on an expedited timeframe.

B. C-V2X Offers Potential Future Safety Benefits to Drivers – And FHWA Should Explore How It Might Facilitate the Deployment of C-V2X Infrastructure

5GAA believes that 5G ultimately will be the underlying technology for V2X for use cases, that cannot be realized over 4G already today. 5G will be able to offer drastically increased data throughput, low latency, and enhanced reliability, further allowing vehicles to share rich, real-time data that will enable fully automated driving experiences.²⁷ Thus, C-V2X has been one of the highest-profile use cases discussed for 5G.²⁸

One of the key benefits of C-V2X is its future evolution path to 5G. While the initial standard for C-V2X is based on LTE, 3GPP's roadmap for future specification envisions enhancements to 5G.²⁹

²⁷ 5GAA: Paving The Way Towards 5G, <http://5gaa.org/5g-technology/paving-the-way/> (last visited Feb. 23, 2018).

²⁸ *Id.*

²⁹ Socio-Economic Benefits of Cellular V2X at 3.

Yet, even as C-V2X evolves, it is designed to remain backwards compatible with previous versions. Consequently, C-V2X will remain an idea technology can build around.

In light of these benefits, the FHWA should work with industry to assess whether any barriers exist for state departments of transportation and relevant local authorities to deploy C-V2X-capable infrastructure. The deployment of C-V2X-capable infrastructure today will avoid lifecycle, technology obsolescence, and sunk costs that may occur with deployment of DSRC-capable infrastructure. In particular, the FHWA should consider whether to include C-V2X in its Architecture Reference for Cooperative and Intelligent Transportation (ARC-IT)³⁰ and whether to allow state and local transportation agencies to use Federal highway funding to make investments in C-V2X-compatible roadside units. By identifying barriers to deployment of C-V2X-capable infrastructure today, the FHWA will help facilitate the deployment of infrastructure that potentially will provide taxpayers with the best value and drivers with the best safety technology of today and tomorrow. 5GAA and its members stand ready to help.

C. C-V2X's Use of the Commercial Mobile Cellular Networks Allows for Added Safety Benefits

C-V2X's safety applications take advantage of the widespread cellular network coverage in the U.S. in a number of ways. For example, the cellular network can be used to achieve centralized resource allocation, which in effect serves as a message "traffic cop" at congested traffic intersections, assigning higher priority to, for example, cars approaching at higher speeds or any other set of criteria the safety algorithm is designed to achieve. In addition, the cellular network can also allow for better prioritization of more important messages in case of channel congestion. In practical terms, this means that low latency V2V basic safety messages are given quick passage and other less urgent messages are routed

³⁰ United States Department of Transportation, Architecture Reference for Cooperative and Intelligent Transportation, <https://local.iteris.com/arc-it> (last visited Feb. 27, 2018).

through appropriate other routes. Yet another feature is that, in environments where V2V traffic is congested, the cellular network can provide a separate transmission path for communications between vehicles. Network assistance for resource management or for packet routing can be provided today with network delays in the order of tens of milliseconds, making cellular infrastructure an exemplary means for responding to safety related use cases. And, finally, while a cellular network is not necessary for transmitting V2V safety messages, using the cellular network can allow a message to be (re)transmitted over a longer range.

IV. RESPONSES TO SPECIFIC QUESTIONS PRESENTED IN THE ADS RFI

The ADS RFI asks how the FHWA can engage with industry and automation technology developers to understand potential infrastructure requirements.³¹ The FHWA should engage with the communications industry as a key enabling industry for vehicle automation, and learn more about the synergistic roles for surface transportation and communications infrastructures. 5GAA as an organization, and its individual member companies, are happy to engage with the FHWA in greater depth on these topics.

The ADS RFI likewise asks how the FHWA can engage with its state and local partners as they consider impacts on infrastructure, transportation funding, finance, and revenue.³² State and local agencies have at times expressed concerns about the deployment of telecommunications infrastructure in roadway rights-of-ways. Often, such deployments have been viewed or portrayed as potentially adversely impacting vehicle safety.³³ C-V2X and 5G network deployments that support connected and

³¹ ADS RFI, 83 Fed. Reg. at 2720 (Question 4).

³² *Id.* (Question 6).

³³ *See, e.g.*, Comments of American Association of State Highway and Transportation Officials, WT Docket No. 17-79, at 3 (filed June 19, 2017) (“AASHTO members ... recommend against allowing encroachments within the right of way or attached to state infrastructure that violate a state’s rights or its agreement with the FHWA to control the right of way. These encroachments may introduce safety hazards to in-place infrastructure, compromise safe travel, affect significant environmental resources and limit an agency’s ability to adequately maintain highway facilities.”).

automated vehicles demonstrate the exact opposite: that communications networks affirmatively improve roadway safety. The FHWA should thus work with industry, as well as state and local partners, to encourage telecommunications infrastructure investments and to coordinate with and accommodate communications network deployments that support vehicle connectivity—both of which further ADS deployment and adoption, and support a mixed fleet of ADS and connected vehicles.

Finally, the ADS RFI asks whether any changes are needed to any of the programs that comprise the Federal-aid Highway Program that can enable state and local agencies to more effectively make infrastructure investments to support deployment of ADS. Some state DOTs are deploying roadside units in areas of high traffic volume, dangerous intersections and tunnels, and using this information to monitor and provide traffic management solutions. 5GAA encourages the FHWA to include C-V2X in its Architecture Reference for Cooperative and Intelligent Transportation and to allow state and local transportation agencies to use Federal highway funding to make investments in C-V2X-compatible roadside units. The FHWA should likewise encourage a cooperative approach between industry, state DOTs and local agencies to achieve the most economical and cost-effective solutions for V2I deployment by adopting compatible C-V2X technologies.

V. CONCLUSION

5GAA urges the FHWA to consider how it can facilitate the deployment of infrastructure and networks supporting C-V2X. As explained herein, by leveraging existing cellular infrastructure and continued industry investment, deployment of C-V2X technology potentially can be achieved at a fraction of the cost of other competing technologies and result in a faster paced role out. Further, C-V2X offers the potential for future safety enhancements as 5G technologies are developed and deployed. In addition, C-V2X's use of the commercial cellular network potentially offers added safety features that are not available with non-cellular devices. By considering how it can facilitate the deployment of infrastructure and networks supporting C-V2X, the FHWA will help ensure that American drivers have

access to a technology that potentially is more cost-effective, more dynamic, and safer than other solutions.

Respectfully submitted,

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March 5, 2018