verizon

**Melissa Glidden Tye**
Associate General Counsel

1300 I Street, NW
Suite 600 West
Washington, DC 20005
Phone 202-515-2459
melissa.tye@verizon.com

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**VIA ELECTRONIC SUBMISSION**

Mr. William Winnie
Office of the Chief Counsel
Federal Highway Administration

Re: *National Standards for Traffic Control Devices; the Manual on Uniform Traffic Control Devices for Streets and Highways; Revision; Proposed Rule, Notice of Proposed Amendments*, FHWA Docket No. FHWA–2020–0001, RIN 2125–AF85

Dear Mr. Winnie:

Verizon submits the following comments and attached Exhibit A with respect to FHWA's consideration of revisions to the Manual on Uniform Traffic Control Devices for Street and Highways, released on December 14, 2020.[1]

Verizon is well known as a leading provider of wireless broadband connectivity in the United States, not only connecting people to one another but connecting people to our physical world, and connecting elements of our physical world to each other. That connectivity holds particular potential for automotive technology, as vehicles are increasingly capable of communicating with each other, road infrastructure, and even pedestrians. Verizon has leveraged its broadband expertise and expansive network to become an industry leader in automotive connectivity, including in-vehicle Wi-Fi, telematics, and cellular vehicle-to-everything connectivity ("C-V2X").

C-V2X connectivity allows a vehicle to communicate with other vehicles, transportation infrastructure, pedestrians, cyclists, and more. C-V2X holds huge potential by enabling vehicles that are much more aware of their surroundings; capabilities include informing a driver of oncoming obstacles, such as a car stopped short up ahead, a traffic signal that is about to turn red, or even a pedestrian walking into a street from behind a parked car. Vehicles equipped with C-V2X can warn drivers of

[1] *See National Standards for Traffic Control Devices; the Manual on Uniform Traffic Control Devices for Streets and Highways; Revision*, 85 FR 80,898 (FHWA Dec. 14, 2020).

potential collisions, assist with emergency braking, monitor intersections, and even help find on-street parking in a crowded downtown.

Verizon's 5G network is particularly well-suited to enable the full potential of C-V2X. Mobile edge computing (MEC) moves data and data processing closer to the end user at the edge of the network. This reduces the round trip that data needs to travel, decreasing latency and helping critical, performance-impacting applications respond more quickly and efficiently. Verizon has partnered with Amazon Web Services (AWS) to bring AWS computing and storage services to the edge of Verizon's 5G Ultra Wideband network, allowing the development of applications with increased speeds, massive bandwidth, and ultra-low latency. And developers are already taking advantage of that technology. Verizon recently announced its partnership with HARMAN, a leader in connected automotive technology, to use Verizon 5G Edge with AWS for 5G Edge-based C-V2X.[2]

The benefits of C-V2X for daily life are clear and widespread, including increased safety, less gridlock, reduced environmental impact, and more creature comforts for drivers and passengers alike.[3] And C-V2X is crucial to the realization of fully autonomous vehicles, providing data and analysis beyond the vehicle line of sight, where on-board sensors cannot reach.[4]

In addition, Verizon recently launched Hyper Precise Location using Real Time Kinematics (RTK), hyper-precise location technology that provides location accuracy within one to two centimeters on the Verizon network. Among other applications, RTK will support emerging technologies enabling mobility that depend on precise location accuracy, such as lane-level navigation needed by first responders during emergencies.

Verizon commends FHWA's decision to include autonomous vehicles in the MUTCD under the newly proposed Part 5. Autonomous vehicle technology has exploded over the past decade, and it's clear that increasing autonomy is the future of

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[2] *See* "Verizon and AWS Bring MEC to Denver and Seattle" (Dec. 28, 2020), https://www.verizon.com/about/news/verizon-aws-denver-seattle-mobile-edge-computing-cities.

[3] *See generally* 5G Automotive Association, *C-V2X Use Cases Volume II: Examples and Service Level Requirements* (Aug. 15, 2020), https://5gaa.org/wp-content/uploads/2020/10/5GAA_White-Paper_C-V2X-Use-Cases-Volume-II.pdf; 5G Automotive Association, *C-V2X Use Cases Methodology, Examples and Service Level Requirements* (June 19, 2019), https://5gaa.org/wp-content/uploads/2019/07/5GAA_191906_WP_CV2X_UCs_v1-3-1.pdf.

[4] *See* GSMA, *Connecting Vehicles, Today and In the 5G Era, With C-V2X* 1, 2, 4 (Aug. 2019), https://www.gsma.com/iot/wp-content/uploads/2019/08/Connecting-Vehicles-Today-and-in-the-5G-Era-with-C-V2X.pdf ("Ultimately, C-V2X will play a pivotal role in enabling the deployment of fully autonomous vehicles, which will transform the way people travel.").

the automotive industry. But the autonomous vehicle landscape has not evolved on the trajectory initially predicted, either with respect to timing or technology. Early estimates expected delivery of fully autonomous vehicles around 2020, but more recent estimates are less optimistic and less precise, estimating that truly autonomous vehicles are still at least several years, and maybe even decades, away.[5] Likewise, while early AV efforts were focused completely on on-vehicle technology, it is now clear that AVs will also utilize C-V2X technology that is located outside of the vehicle.[6]

The proposed MUTCD does not reflect the important role that C-V2X will play in the AV ecosystem. Rather, proposed Part 5 focuses on earlier, and now outdated, AV design, where the vehicle itself contained all of the technology that enabled autonomous operation, such as cameras, radar, LiDAR, and GPS. C-V2X is already recognized as an important safety component for all vehicles, and many of those safety benefits will translate directly to the AV ecosystem as well.

As telecommunications networks evolve, particularly with the deployment of 5G and MEC, C-V2X will become more and more capable of supporting automated driving system (ADS) tasks as well as or even better than some on-vehicle technologies.[7] For instance, C-V2X will often provide greater awareness of the surrounding area, that is,

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[5] *See* Eric Adams, *Why We're Still Years Away From Having Self-Driving Cars*, Recode (Sep. 25, 2020), https://www.vox.com/recode/2020/9/25/21456421/why-self-driving-cars-autonomous-still-years-away; John J. Leonard, *et al*., *Autonomous Vehicles, Mobility, and Employment Policy: The Roads Ahead*, MIT Work of the Future 4-5 (July 2020), http://workofthefuture.mit.edu/wp-content/uploads/2020/11/2020-Research-Brief-Leonard-Mindell-Stayton3.pdf; Kelsey Piper, *It's 2020. Where Are Our Self-Driving Cars?*, Vox (Feb. 28, 2020), https://www.vox.com/future-perfect/2020/2/14/21063487/self-driving-cars-autonomous-vehicles-waymo-cruise-uber.

[6] *See, e.g.*, Ralf Llanasas, *5G's Important Role in Autonomous Car Technology*, Machine Design (Mar. 11, 2019), https://www.machinedesign.com/mechanical-motion-systems/article/21837614/5gs-important-role-in-autonomous-car-technology; Kearney, *5G: A Key Requirement For Autonomous Driving – Really?*, https://www.kearney.com/communications-media-technology/article/?/a/5g-a-key-requirement-for-autonomous-driving-really-.

[7] *See* Keith Mallinson, "How C-V2X In 5G Will Transform Cars and Save Lives (Analyst Angle)," RCR Wireless News (Feb. 6, 2020), https://www.rcrwireless.com/20200206/analyst-angle/c-v2x-5g-transform-cars-analyst-angle ("While sensors including cameras and light detection and ranging LIDARs can help a vehicle read the road, all such technologies have difficulties in some instances. For example, road markings disappear in snow and objects including obstructions may be misinterpreted. … Communications among cars, with nearby infrastructure (e.g., lamp poles) and with the network will complement sensor technologies and enable much-improved accuracy and reliability to be achieved in conjunction with AI software.").

will enable the vehicle to see or sense activity happening outside of the view of the on-board sensors, such as the presence of pedestrians on a sidewalk lined by parked cars.

C-V2X also makes it possible to locate the computing capability outside of the vehicle, which can reduce the costs of ADS technology, making the technology more affordable, and therefore accessible to more people and increasing the pace of adoption. C-V2X makes use of the faster upgrade cycle for telecommunications infrastructure. Today, the average age of vehicles on the road in the United States is 11.9 years.[8] And while some estimate that the current fleet of automobiles on the road takes 15 years to turn over, market trends have shown that consumers are keeping their vehicles increasingly longer.[9] Meanwhile, wireless carriers invest billions of dollars each year, constantly upgrading infrastructure to meet the demands of the competitive wireless marketplace. So drivers may gain the benefits of ADS technology at a faster rate through C-V2X, rather than if they have to purchase a new vehicle to obtain the technology. That reality is in part behind the recently announced partnership between Verizon and Honda to facilitate Honda's SAFE SWARM technology.[10] SAFE SWARM enables vehicles to communicate with other road users and share key information, such as location, speed, and vehicle sensor data. However, it requires outfitting each vehicle with onboard artificial intelligence (AI) capabilities. But by using 5G, the AI capabilities move from the vehicle to the MEC, reducing the need for AI onboard each vehicle.

Given the importance of C-V2X in the evolving automated driving ecosystem and its ability to bring ADS to more people on a faster timeline, FHWA should revise proposed Part 5 to better reflect the likely technological trajectory for self-driving vehicles. First, FHWA should change the title of Part 5 to "Automated Driving Systems," which not only mirrors the terminology used by NHTSA,[11] but also better reflects the complete ecosystem of automated vehicle technology. Following that, references to "autonomous vehicles" elsewhere in Part 5 should be changed to

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[8] Colin Beresford, "Average Age of Vehicles on the Road Is Approaching 12 Years," Car and Driver (July 29, 2020), https://www.caranddriver.com/news/a33457915/average-age-vehicles-on-road-12-years/#:~:text=A%20study%20from%20IHS%20Markit,vehicles%20on%20the%20road%20higher.

[9] *See* Hart Schwartz, "America's Aging Vehicles Delay Rate of Fleet Turnover," The Fuse (Jan. 23, 2018), http://energyfuse.org/americas-aging-vehicles-delay-rate-fleet-turnover/; "U.S. Households Are Holding Onto Their Vehicles Longer," U.S. Energy Info. Admin. (Aug. 21. 2018), https://www.eia.gov/todayinenergy/detail.php?id=36914.

[10] *See* "Verizon and Honda Test How 5G Enhances Safety for Connected and Autonomous Vehicles" (Apr. 8, 2021), https://www.verizon.com/about/news/verizon-honda-test-5g-connected-autonomous-vehicles.

[11] *See*, *e.g.*, *Framework for Automated Driving System Safety*, Advanced Notice of Proposed Rulemaking, 85 FR 78,058 (NHTSA Dec. 3, 2020).

"automated driving systems (ADS)," as appropriate. Further, in Section 5A.02 *Overview of Connected and Automated Vehicles*, the MUTCD should include C-V2X as a source of information for autonomous operation. And in Section 5A.03 *Definitions and Terms*, the MUTCD should include definitions for C-V2X, along with the various iterations thereof, such as V2I and V2P.

Verizon supports FHWA's recommendation for the adoption of V2I in Section 5B03 *Highway Traffic Signals* and agrees with FHWA's statement therein that the number of variables can make consistency in the roadway design around traffic signals challenging. But FHWA should not hedge its language on this important topic, and should simply state that V2I provides the most consistent, accurate, and reliable information regarding traffic signals in a machine readable format, and should therefore be implemented in all traffic signals.

Finally, C-V2X also has great potential to protect the most vulnerable members of the traffic ecosystem – pedestrians. While on-vehicle AV technology is able to identify and take some safety actions around pedestrians, C-V2X can provide even greater safety assurances. For that reason, the MUTCD should also recommend installation of cameras and C-V2X technology in all pedestrian traffic signals (e.g., Walk/Don't Walk signs, school zone signs, etc.). Cameras embedded in these devices will help provide additional pedestrian identification in those areas where there are likely to be more pedestrians, while C-V2X technology connected to the cameras can relay information to vehicles. And even apart from the cameras, C-V2X technology installed in the roadside infrastructure can also communicate with wireless devices that pedestrians carry, providing another source of data that can be used to improve safety.

In conclusion, Verizon appreciates FHWA's effort to revise the MUTCD to account for the evolving technology of the automotive industry. As part of the revisions, Verizon urges FHWA to better account for the entire ecosystem of which autonomous vehicles are a part, and more specifically, for the essential role that C-V2X will play in that ecosystem.

Respectfully submitted,

/s/

Melissa Glidden Tye
Associate General Counsel
Verizon
1300 I Street NW, Suite 600 West
Washington, DC 20005

**Comments on Docket No. FHWA-2020-0001 National Standards for Traffic Control Devices; *the Manual on Uniform Traffic Control Devices for Streets and Highways*; Revision**

**TABLE 1. ORIGINAL COMMENTS ON PROPOSED CHANGES.**

| Proposed Section Number(s) | Agree with concept and text as proposed | Agree with concept; suggested rewording of text in Comments | Disagree with concept | Comments<br>*Please include justification for your position based on objective experience and empirical data. If there is a specific statement with which you take exception, please provide the Page and Line numbers from the mark-up version of the proposed MUTCD text.* |
|---|---|---|---|---|
| (**EXAMPLE**) 1D.08 | YES | N/A | N/A | Agree - maintains uniformity. |
| (**EXAMPLE**) 2E.41, 2E.42 | NO | YES | N/A | Agree with the alternate proposal that freeway and expressway Diagrammatic signs should be discontinued, contingent upon the adoption of the Partial-Width Overhead Arrow-per-Lane signs, which should allay concerns over excessively wide and costly signs at non-major interchanges. |
| (**EXAMPLE**) 2E.42 | NO | YES | N/A | Agree that the proposed Modified or Partial-Width Overhead Arrow-per-Lane sign should be adopted, but do not agree with exception for an existing Exit Direction sign to remain at the theoretical gore (p. 189, Lines 39-44). This exception creates a non-uniform application and violates the expectancy of the road user. |
| Part 5 | NO | YES | N/A | Change title to “Part 5 – Automated and Connected Vehicles” or “Advanced Driving Systems” to reflect broader scope of vehicle technology. |
| 5A.01 | NO | YES | N/A | Include connected vehicle or Automated Driving Systems in the purpose and scope, rather than simply “Automated Vehicles” to better reflect the broader scope of advanced vehicle technology. Note that Part 5A.02 already refers to “connected vehicle technology.” |
| 5A.02 | NO | YES | N/A | Include telematics and C-V2X as a resource for information.<br><br>Modify lines 38-40 to read: “AVs may combine sensor data with other inputs including detailed map and road geometry data, and information from other connected vehicles or infrastructure, including signal phase and timing messages from traffic signal controllers.” |
| 5A.03 | NO | YES | N/A | Include definition of C-V2X and iterations thereof (e.g., V2I, V2P, etc.) among definitions section. |
| 5B.03 | NO | YES | N/A | Change final sentence in Support statement to “Connected and automated vehicles (CAV) needs with respect to traffic signals are better addressed through vehicle to infrastructure (V2I) with MAP and Signal Phase and Timing (SPaT) technology, for the reasons stated above and for reliability and accuracy of critical communications under all environmental conditions.” |
| 5B.07 | NO | NO | YES | Add “Section 5B.07 Traffic Control for Pedestrian Facilities.” Recommend the addition of cameras connected via C-V2X to provide protection for pedestrians in or around the roadways. |

**TABLE 2. AGREE WITH ANOTHER COMMENTER.**

| Docket Comment Number and/or Commenter Name | Agree with commenter’s comments as written | Agree with commenter; with exception(s) | Additional information helpful to FHWA, or exceptions to commenter’s comments |
|---|---|---|---|
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