**DEPARTMENT OF TRANSPORTATION**
**Office of the Secretary**

**V2X Communications**
**Request for Comments**
**Docket No. DOT-OST-2018-0210**

# Comments of AT&T Services, Inc.

## INTRODUCTION

AT&T Services, Inc., on behalf of itself and its affiliates (together, "AT&T"), respectfully submits these comments in response to the Department of Transportation ("DOT") Request for Comments, seeking information on vehicle-to-vehicle (V2V), vehicle-to-infrastructure (V2I), and vehicle-to-pedestrian (V2P) communications—or "V2X" communications.

AT&T is a leader in providing cellular network connectivity to motor vehicles in the United States and is providing global connectivity solutions to automotive manufacturers around the world. As of the end of 2018, AT&T had business relationships with 31 global automotive brands[1] and had connected over 25 million vehicles to its network. In fact, AT&T has added more than 1.5 million connected cars to its network for each of the past eight consecutive

[1] These include: Airstream, Audi, BMW, Buick, Cadillac, Chevrolet, Chrysler, Dodge, Ford, Freightliner, GMC, Honda, Infiniti, Jaguar, Jeep, Land Rover, Lincoln, Lexus, Mercedes-Benz, Navistar, Nissan, Opel, Porsche, Ram, Skoda, Subaru, Tesla, Toyota, Vauxhall, Volvo and VW.

quarters.

AT&T is a board member of the 5G Automotive Association ("5GAA"), which is developing V2X and Cooperative Intelligent Transportation System technologies in a global collaboration between the communications and automotive industries.[2] AT&T was also among the first non-automotive original equipment manufacturer members to join the Auto-ISAC in 2016, engaging in automotive cybersecurity information sharing and developing best practices. Most recently, AT&T joined the TennSMART coalition as a board member to work at the state level in a public-private consortium developing intelligent mobility solutions.[3]

In addition to our direct role in supporting vehicle connectivity, AT&T is also partnering with cities, municipalities, and other entities in Smart City efforts, including addressing communications for transportation-related objectives. AT&T is a strategic partner to DOT's Smart City Challenge.[4] As part of that effort AT&T is working with the city of Columbus, Ohio on delivering on its Smart City vision.[5] The American Center for Mobility (ACM) in Ypsilanti, MI selected AT&T to be its exclusive wireless communications provider through 2020.[6] There, AT&T and ACM are working together on research and development of self-driving connected and automated vehicles—including exploring cellular support for infrastructure elements of V2X deployments. And, as is discussed in greater detail below, in 2016 AT&T was one of the first mobile network operators to demonstrate in a live network environment the complementary

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[2] Website, 5GAA, *available at* http://5gaa.org/about-5gaa/about-us/.

[3] Website, TennSMART, *available at* http://tennsmart.org/.

[4] Press Release, *US Department of Transportation adds AT&T to Smart City Challenge*, June 9, 2016, *available at* https://www.transportation.gov/briefing-room/us-department-transportation-adds-att-smart-city-challenge.

[5] *See* SmartColumbus, *available at* https://www.columbus.gov/smartcolumbus/.

[6] Release, *AT&T and the American Center for Mobility Fuel the Future of Automated Driving*, Jan. 4, 2017, *available at* http://about.att.com/story/future_of_automated_driving.html.

capabilities of cellular V2N communications to V2V communications.[7]

Key to AT&T's leadership in connecting vehicles is the strength and breadth of our networks. Between 2013 and 2017, AT&T invested more than $145 billion in its wireline and wireless networks, including the acquisitions of spectrum and wireless operations. This represents the largest investment in the United States by any public company. As a result, the overwhelming majority of the mileage of the U.S. National Highway System is covered by AT&T's cellular network. AT&T is leading in the deployment of 5G, as the first U.S. carrier to introduce a standards-based, mobile 5G network and device.[8] It is continuing to build its new 5G network and plans to provide nationwide mobile 5G coverage by early 2020, using lower band (below 6 GHz) spectrum.[9]

AT&T also has a long commitment to road safety. In 2009 we launched the It Can Wait® campaign to reduce driver distraction resulting from the use of portable devices. As one of the largest fleet operators in the nation, with more than 84,000 vehicles (mostly light trucks and vans) operated by our employees,[10] AT&T was one of the founding members of the Together for Safer Roads Coalition,[11] seeking to identify ways private sector companies can work together to reduce global road fatalities.

Given AT&T's extensive involvement in connected vehicles and transportation safety, and its expertise in securely connecting all manner of devices, AT&T is pleased to provide the

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[7] Release, *AT&T, Delphi, and Ford Debut V2X Advanced Vehicle Communications*, Jan. 4, 2017, *available at* http://about.att.com/story/att_debuts_v2x_advanced_vehicle_communications.html.

[8] Release, *AT&T First to Make Mobile 5G Service Live in the U.S. on Dec. 21*, December 18, 2018, *available at* https://about.att.com/story/2018/att_brings_5g_service_to_us.html.

[9] Release, *First in the U.S. to Mobile 5G — What's Next? Defining AT&T's Network Path in 2019 and Beyond*, *available at* https://about.att.com/story/2019/2019_and_beyond.html.

[10] Company Fleet and Transportation, 2018, *available at* https://about.att.com/csr/home/issue-brief-builder/environment/company-fleet-and-transportation.html.

[11] Website, Together for Safer Roads, *available at* http://www.togetherforsaferroads.org.

responses to DOT's request for comment.

## DISCUSSION

### I. GENERAL COMMENTS ON V2X COMMUNICATIONS

#### A. V2X Communications Technologies in Support of Vehicles and Surface Transportation Are Not Limited to V2V, V2I and V2P.

In its request for comments, the Department identifies V2X technologies as encompassing V2V, V2I, and V2P communications. These are critical and necessary instances of V2X communications—but they are neither the totality of V2X communications nor sufficient in and of themselves to wholly enable the broader V2X-enabled suite of applications and use cases. Vehicle-to-network ("V2N") and network connected Intelligent Transportation System ("ITS") infrastructure communications[12] play an important role in V2X communications, both as a supporting element to the short-range communications and as a delivery method in its own right for important V2X services. Vehicles and infrastructure elements will require Wide Area Network ("WAN") access to enable, support, and complement the V2V/V2I communications and corresponding safety applications—and cellular technologies enabling V2N services often provide the best means of supplying this WAN access.

Mobile networks are increasingly being used to support both ITS infrastructure and V2N communications. An example of these transportation infrastructure-to-network use cases include the recent deployment by Applied Information, in partnership with AT&T, of connected school

[12] Functionally, this could be termed "infrastructure-to-network" ("I2N") communications, but to avoid any complications—not to mention the addition of yet another acronym to an already crowded field—we subsume this term within "V2N," with the "V" here accommodating both vehicles and transportation infrastructure elements.

beacons in Georgia.[13] Connecting these beacons allows traffic engineers to monitor the operation of the school beacons and provide timely service to them. Applied Information is also enabling signal phase and timing ("SPaT") and other Connected Vehicle messaging derived information, in Georgia and other locations around the U.S., to be made available via V2N services to mobile handsets (usable by motorists and pedestrians) with the TravelSafely app.[14] Audi has recently expanded its use of V2N connectivity to provide similar information to drivers through the in-vehicle systems of certain Audi models, enabling its Green Light Optimization Speed Advisory feature.[15] Clearly, these kinds of V2N solutions are already meeting some of the objective use cases and applications of ITS and V2X technologies.

In both this RFC and its recent Automated Vehicle 3.0 policy, the Department noted the increased pace of short-range V2X technology deployment and development activity.[16] As automotive manufacturers and road infrastructure owners and operators ("IOOs") continue to expand and accelerate this deployment, V2N connectivity will continue to grow in importance in supporting the short-range V2X technologies. This support may entail functions such as enabling the WAN access needed for the V2X security architecture services, connecting V2I infrastructure elements where wireline fiber connectivity may not be feasible, or even providing V2I and V2V applications in some instances, e.g. beyond the range achievable by short-range communications protocols. AT&T's proof of concept work noted above and its current ITS-

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[13] Releases, *AT&T and Applied Information Help Make Georgia School Zones Safer with Internet of Things Technology*, August 1, 2018, available at https://about.att.com/newsroom/georgia_school_zone_safety.html, and *Georgia School Zones Made Safer with Internet of Things Technology Ahead of the New School Year*, August 1, 2018, available at https://appinfoinc.com/georgia-school-zones-made-safer/.

[14] Website, Applied Information, *available at* https://appinfoinc.com/solutions/glance-travelsafely/#ts-leverage

[15] *See* https://www.forbes.com/sites/samabuelsamid/2019/02/19/expanded-audi-v2i-communications-helps-drivers-hit-green-lights/#4f215fcc48ce

[16] U.S. Department of Transportation, *Preparing for the Future of Transportation: Automated Vehicles 3.0*, 2018, *available at* https://www.transportation.gov/AV.

supporting deployments illustrate these possibilities.[17]

AT&T takes no position at this time on the specific short-range wireless technology to be used for the communication between vehicles or vehicles and roadside infrastructure—i.e. between DSRC and C-V2X (PC5). DSRC technology is a viable means of achieving the Department's policy objectives for connected vehicles and has gained market support from both automotive OEMs and the IOO community in recent years.[18] Deploying DSRC in both vehicles and infrastructure is obviously possible, and happening, today. As the RFC also recognizes, there are other rapidly emerging 3GPP-based technologies, including the C-V2X (PC5 interface) standards defined in 3GPP Releases 14 and 15,[19] that may offer improved radio air interface performance relative to DSRC. This in turn may offer both safety and other market benefits.[20]

With respect to C-V2X, it is important to note that the C-V2X (Uu) air interface for long-range / V2N communications is, at the radio access protocol and bearer level, functionally the same as the connections provided to most vehicles already equipped with LTE connectivity. The 3GPP standards for C-V2X (Uu) allow for certain additional elements (e.g. a "V2x server") in a mobile network that can facilitate delivery of V2N/V2X applications and services.[21] Such an element may expand the range of applications and use cases enabled over the Uu—or existing

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[17] *See* Comments of AT&T Services, Inc. to Vehicle-to-Vehicle Notice of Proposed Rulemaking Docket No. NHTSA-2016-0126, April 12, 2017.

[18] See Release, *Cadillac to Expand SuperCruise Across Entire Lineup*, (June 6, 2018), *available at* https://media.cadillac.com/media/us/en/cadillac/news.detail.html/content/Pages/news/us/en/2018/jun/0606-its-cadillac.html; Release, *Toyota and Lexus to Launch Technology to Connect Vehicles and Infrastructure in the U.S. in 2021*, (April 16, 2018), *available at* https://toyotanews.pressroom.toyota.com/releases/toyota+and+lexus+to+launch+technology+connect+vehicles+infrastructure+in+u+s+2021.htm;Website, *SPaT Challenge Overview*, *available at* https://transportationops.org/spatchallenge.

[19] 3GPP Specifications associated with Work Item, *available at* http://www.3gpp.org/DynaReport/WiVsSpec--700261.htm.

[20] *See* 5GAA Petition for Waiver, FCC GN Docket No. 18-357, (November 21, 2018) *available at* https://www.fcc.gov/ecfs/filing/11212224101742.

[21] *See, e.g.,* 3GPP TR 36.885 V14.0.0 (2016-06), p. 24-34.

LTE—connection to vehicles. But, as the V2N services noted above illustrate, useful V2N services already can be offered over LTE through existing network architectures.

The scope of V2N use cases can be expected to expand as mobile network operators continue to deploy 5G and as automotive manufacturers eventually move to incorporate 5G connectivity into their vehicles. However, LTE will remain more broadly available for quite some time, and its utility for V2X and V2N services should not be overlooked. To underscore this, simultaneous with the current 5G network build and deployment AT&T and other operators are improving the capabilities of their existing 4G LTE networks through a combination of LTE Advanced technologies like 256 QAM, 4x4 MIMO, and 3-way carrier aggregation.[22] These leverage the existing coverage of the LTE network while significantly improving its performance, in terms of both capacity and throughput—and help prepare the network for 5G deployment.

Another key element of this work to improve LTE and prepare for 5G is the significant deployment of more fiber infrastructure and small cells to densify the network and bring it closer to customers. For its part, AT&T is deploying thousands of small cells on existing infrastructure elements such as streetlights and utility poles. Given the utility of V2N services, much less prospective V2I services, there is opportunity for collaboration with the Department and state and local IOOs on the deployment of a full range of V2X technologies in conjunction with this small cell deployment.

### B. Proper Use of the 5.9 GHz Band is Critical to V2X Deployment.

A prerequisite to advancing many forms of V2X technology is the swift and fulsome

[22] Andre Fuetsch, blog post, "Setting the Record Straight on 5G Evolution," April 19, 2018, *available at* https://about.att.com/innovationblog/5g_evolution_record.

employment of the 5.9 GHz band for the purposes for which the Federal Communications Commission ("FCC") allocated it. This is the spectrum that currently enables the unencumbered short-range, peer-to-peer direct communications that are so vital to many V2X safety applications, for both conventional and automated vehicles. The Department wrote of the importance of this spectrum, and its work "to preserve the ability for transportation safety applications to function in the 5.9 GHz spectrum," in its AV 3.0 policy document.[23] AT&T recognizes the importance and utility of this band to V2X technology and supports its preservation for transportation safety applications as well.

The continued, rapid deployment of V2X technologies in the 5.9 GHz band, as well as of ITS use of the band, is needed to ensure that the full band remains available. Indeed, the public interest case for preserving the band could be weakened if V2X deployment is slowed or stalled due to uncertainty among industry and government stakeholders (such as IOOs that must make investment decisions) over the technologies to be used for short-range direct V2X communications. Accordingly, industry and the Department should rapidly bring the technology debate to a clear resolution such that V2X deployment can continue apace. This RFC is an important step toward that end, but it must be followed up quickly by further actions by the Department to provide clarity and certainty to all stakeholders about technologies to be used for short-range, direct V2X communications.

### C. While Policies to Promote V2X Deployment Must Generally Be Technologically Neutral, DOT Must Select A Single Short-Range Direct Radio Communications Protocol to Support the ITS and V2X Ecosystem.

A "general desire to remain technologically neutral and avoid interfering with the many

[23] U.S. Department of Transportation, Preparing for the Future of Transportation: Automated Vehicles 3.0, p. 16.

innovations in transportation and telecommunications technologies"[24] on the part of the Department and other government policy makers is *almost* always salutary and the correct policy aim. Such a position lets those private sector entities who are best positioned - and expending capital - to make technology choices decide what will work best for their products, services, and customers.

That said, in select and narrow public safety matters complete technological neutrality may not be a viable policy position because it can (a) greatly impede the delivery of the intended safety benefits of the technology and (b) impose additional non-market-based costs (in money and time) to achieve the interoperability between otherwise incompatible technologies that is necessary to achieve the desired safety benefits. This impact is even more pronounced when governments themselves, whether Federal, state, or local, are significant customers for and/or deployers of the technology. Here, the financial cost inefficiencies associated with achieving interoperability are borne by taxpayers, and not just consumers or the industry proponents of the technologies.

In the case of V2X technologies, 23 USC §501 defines "standard" as a document that "may support the national architecture" – itself a defined term that means "the common framework for interoperability"[25]- and "promote (i) the widespread use and adoption of intelligent transportation system technology as a component of the surface transportation systems of the United States; and (ii) interoperability among intelligent transportation systems technologies implemented throughout the States."[26] Thus, to achieve the benefits of the Intelligent Transportation System as directed by Congress, DOT must make decisions that

[24] U.S. Department of Transportation, V2X RFC at 66339.

[25] 23 USC §501(6).

[26] 23 USC §501(9).

implement common communications architectures that enable interoperable cross-device, cross-element communications. As the Department is well aware, without interoperability the safety benefits derived from the network effect of V2X communications will not scale. The most foundational level of those architectures—and where there is the greatest need for commonality, and the greatest costs in its absence—is the radio access protocol supporting short-range, direct V2X communications.

It certainly is reasonable—indeed very much desirable—for DOT to remain technology neutral about long-range V2X capabilities, other ITS applications and services, and automated vehicle technologies. For these, interoperability is either much more simply achieved or not required to deliver a public benefit.

However, DOT cannot remain technologically neutral on the radio protocol for short range peer-to-peer communications and expect an effective and efficient deployment of V2X technology. At the very best, maintaining that posture will marginally impact deployment timelines while imposing duplicative costs on both industry (e.g. OEMs) and governments (IOOs)—and thus tax payers—to achieve interoperability between "competing" V2X protocols. At worst, such a policy will unacceptably retard V2X deployment, as many stakeholders may delay investing to see how the technology competition shakes out. This not only would impose the direct financial costs associated with achieving interoperability, but also conceivably would result in lives lost in automobile accidents that arguably could have been prevented if deployment had not been delayed. Such a delay also potentially risks the sustained viability of retaining the allocation of the 5.9 GHz band for ITS use, and thus the viability of the short-range, peer-to-peer (e.g. V2V and V2I) components of V2X communications. The Department must therefore move quickly to select and endorse a single short-range direct radio communications protocol to undergird and advance the broader ITS and V2X ecosystem.

### D. DOT Should Continue International ITS Coordination and Assess Global Developments in V2X Technologies.

As the Department recognizes, globally harmonized ITS architectures and standards reduce costs, help achieve economies of scale, and promote cross-border interoperability.[27] This applies to short-range, direct V2X communications technologies as well. The questions posed by the Department in this RFC are also being addressed in regions around the world, most recently in Europe. The European Commission's Cooperative-Intelligent Transportation System Delegated Regulation proposal was provided for a public consultation that concluded earlier this month.[28] Notably, the European Commission's proposal explicitly endorsed a "'hybrid communication' approach" that integrates short-range ITS-G5 (i.e., DSRC) in the 5.9 GHz band with longer-range 3G/4G cellular technologies "for less time-critical V2I services."[29] This hybrid approach formally recognizes the utility of the V2N capabilities discussed above within the broader V2X environment. In Asia, China proposed adopting LTE-V in the 5.9 GHz band in 2018,[30] while Japan currently has significant V2I deployments.[31]

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[27] Fischer, Stephanie, Elizabeth Machek, Hannah Rakoff, and Suzanne Sloan. n.d. "European Union-United States–Japan Cooperation on Intelligent Transportation Systems Research and Deployment: 2017 International Accomplishments Summary." Edited by John A. Volpe National Transportation Systems Center (U.S.). *available at* https://rosap.ntl.bts.gov/view/dot/37393, p. 12.

[28] *See Feedback received on: Specifications for the provision of cooperative intelligent transportation systems (C-ITS)*, February 8, 2019, *available at* https://ec.europa.eu/info/law/better-regulation/initiatives/ares-2017-2592333/feedback_en?p_id=351850.

[29] European Commission, Draft Delegated Regulation - Ares (2019)153204, *available at* https://ec.europa.eu/info/law/better-regulation/initiative/1381/publication/351850/attachment/090166e5c08e86e9_en.

[30] Public Consultation, Ministry of Industry and Information Technology of the People's Republic of China, July 7, 2018, *available at* http://zmhd.miit.gov.cn:8080/opinion/noticedetail.do?method=notice_detail_show&noticeid=1960.

[31] GAO Report, Intelligent Transportation Systems: Vehicle-to-Infrastructure Technologies Expected to Offer Benefits, but Deployment Challenges Exist (GAO-15-775, September 2015), pgs. 23, 26-27, 30.

Global harmonization should remain a key factor for DOT as it assesses short-range, direct V2X communications technologies. Issues of economies of scale, interoperability across regions, and speed of deployment should be considered, as well as geopolitical dynamics pertaining to trade and security.

## II. Responses to Specific RFC Questions

In addition to the comments offered above, AT&T provides some amplifying information in response to some of the specific questions posed in this RFC.

***"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."***

As noted above, record data available in response to the NHTSA V2V mandate NPRM and in several subsequent FCC proceedings indicate that both DSRC and C-V2X (PC5) meet the requisite performance parameters for short-range, direct V2X communications.[32] Each technology also has active developmental paths in their respective standards bodies: the IEEE 802.11 Next Generation V2X ("NGV") Study Group is advancing DSRC technology in a way that purports to be backward compatible with existing DSRC deployments[33] and the 3GPP standards process continues to advance V2X technologies (C-V2X (PC5) and (Uu) interfaces and 5G NR) through Releases 15 and 16 of its standards. Neither short-range direct technology appears to want for future developmental options.

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[32] *See, e.g.* comments of Autotalks LTD to FCC GN Docket No. 18-357, January 18, 2019, *available at* https://www.fcc.gov/ecfs/filing/101181977420288.

[33] *See* Comments of IEEE 802 LAN/MAN Standards Committee to FCC GN Docket No. 18-357, January 17, 2019, p. 3-5, *available at* https://www.fcc.gov/ecfs/filing/101182290315587.

Technological readiness for deployment of C-V2X aside, given the current state of 47 CFR Part 90 and part 95 rules requiring DSRC in the 5.9 GHz band, an FCC rulemaking would be needed to fully enable a sustainable and large-scale deployment of C-V2X (PC5) for production vehicles and infrastructure equipment. 5GAA's petition for a waiver, currently pending before the FCC, seeks to jumpstart this deployment timeline.

Long-range V2N communications for V2X services are already ably handled by 4G LTE (functionally equivalent to "LTE-V" or C-V2X (Uu)) and will naturally migrate to the 5G networks now being deployed by network operators over the course of automotive manufacturer's design cycles—just as those manufacturers migrated production of vehicles equipped with 2G or 3G to 4G LTE. Given that a preponderance of new vehicles from many manufacturers are now equipped with embedded V2N connectivity, it seems likely that that V2N capability will remain in use in vehicles regardless of the short-range direct V2X technology implemented by the manufacturer.

***"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?"***

While some degree of functional interoperability between differing short-range direct V2V/V2I communications—e.g. DSRC and C-V2X (PC5)—may be technologically feasible, implementing that interoperability would present a wide array of challenges. Because those two technologies cannot coexist in the same channel, to achieve true interoperability a short-range V2X system would have to be able to listen for and respond to both protocols. This need could drive a requirement for some additional hardware and software elements in the V2V/V2I equipment, adding complexity in the implementation and possibly causing design and/or performance compromises as a result.

Long-range V2N communications can interoperate with each of the various short-range V2X technologies. AT&T has demonstrated this with both DSRC and C-V2X (PC5).[34] Since the long-range V2N communications (e.g. 4G LTE) operate on a variety of licensed spectrum bands, separate from the 5.9 GHz band, the implementation in V2X equipment can be independent of the short-range communications. Although there may be some unit-level benefits to integration of V2N communications with C-V2X, any such benefits likely would be largely offset by a requirement to interoperate with DSRC.

***"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?"***

There are distinct advantages to using a single communications protocol for short-range, direct peer-to-peer communications for V2V, V2I, and V2P safety applications.

First, a single communications protocol would maximize the efficient use of the spectrum available by enabling access to the full allocation of the 5.9 GHz band for the common protocol. Whether in accordance with the existing channel plan, and its current allocation of seven 10 MHz channels with the possibility of two 20 MHz channels, or a subsequent channel plan enabling certain wider channels needed by advanced V2X applications using either IEEE V2X NGV or C-V2X 5G NR, a common protocol across the full band is a prerequisite for the optimized use of the band. This then also enables the widest set of safety applications to be used

[34] Release, *AT&T, Delphi, and Ford Debut V2X Advanced Vehicle Communications*, Jan. 4, 2017, *available at* http://about.att.com/story/att_debuts_v2x_advanced_vehicle_communications.html. See also 5GAA's further development of C-V2X (PC5) and C-V2X (Uu).

across the band, as appropriate channels would be available to all short-range V2X equipped devices for all applications. Were multiple short-range protocols to be allowed, each would have a more limited number and size of channels available, which could limit the applications that could be delivered.

Second, a single communications protocol for V2V/V2I communications will reduce V2X system complexity. This applies both within individual instances of V2V or V2I equipment and across the range of short-range, peer-to-peer devices intended to communicate with one another. A single protocol eliminates the additional technical overhead associated with achieving some degree of systemic (if not protocol level) interoperability.

Third, a single communications protocol will reduce the total system cost for V2X equipment manufacturers, consumers, and taxpayers. Complexity of radio design adds cost, as does redundancy to achieve interoperability.

***"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?"***

As indicated by the existing V2N services described above,[35] many mobility and environmental type applications originally envisioned for V2I connectivity can be satisfactorily delivered by V2N connectivity independent of the short-range, direct V2X communications protocol. These kinds of applications achieve interoperability across elements (vehicles, infrastructure) through the networks involved. As network performance continues to improve and coverage (both 4G LTE and 5G) expands, the set of mobility and environmental use cases

[35] *See supra*, Applied Information's TravelSafely and Audi's Green Light Optimization, n.14, 15.

addressable by V2N versus V2V/V2I communications is likely to expand.

However, some V2I and V2P applications will still require short-range direct communications in the 5.9 GHz band. Different V2X applications or use cases do have differing technical requirements for their communications. These can include parameters such as latency, data rate, transmission frequency, and message size or data payload; the combination of these parameters then also drives differential spectral bandwidth requirements to support the application.

***"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?"***

There are at least four ways in which communications technologies support automated vehicles ("AVs"): (1) safety—with communications a complementary input to on-board sensors; (2) AV data exchanges—enabling upload and download of the massive amounts of data generated or required by AVs; (3) support for operational employment of AVs—i.e., enabling humans to request, dispatch, and otherwise interact remotely with unoccupied Level 4 or Level 5 AVs; and (4) in-vehicle infotainment—providing human occupants of AVs access to mobile broadband to support productivity and entertainment use cases. Each of these four roles entails different requirements for communications technologies, and it is likely that a combination of various methods will be employed by AVs—short-range V2X, V2N over mobile broadband, satellite, and even Wi-Fi all may play a role in AVs.

The first and most important use for communications in supporting AVs is safety. Primarily, the safety applications enabled by short-range peer-to-peer V2X communications will support AV safety in ways similar to the benefits provided by human driven, but V2V/V2I equipped, vehicles. As the Department also identified in its Automated Vehicle 3.0 policy,[36] V2X communications also will provide a complementary data set and non-line-of-sight awareness of the driving environment for the Automated Driving System ("ADS"). As described above, long-range V2N services over mobile networks will play a supporting role to the short-range, peer-to-peer V2V/V2I safety applications for AVs just as they do for human driven vehicles.

Automated vehicles generate enormous amounts of data. It is through analysis of the data generated while driving that an ADS can be improved over time. This then leads to the second use for connectivity by an AV: the ADS system provider or AV manufacturer must be able to access and retrieve the data from the AV to conduct this analysis, and then must be able to send back to the automated vehicle software and firmware improvements to enable improved (and safer) performance. Mobile broadband, i.e. 4G LTE and 5G networks, can support this use case. As the data to be relayed from and to the AV increases over time, the enhanced mobile broadband attributes of 5G networks will become increasingly important. The 5G networks will be able to support swift uploads of massive amounts of AV data and fast downloads of vehicle updates. Another critical function of the V2N enabled over-the-air updates is to provide on-going cybersecurity updates to the AV. Already important for conventional vehicles, preserving the cybersecurity of AVs will be crucial to their safety and consumer acceptance. The Department appropriately identified this as a topic area of known standards development activities relevant to AVs.[37]

If a Level 4, or eventually Level 5, AV is in service but unoccupied, humans will

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[36] U.S. Department of Transportation, Preparing for the Future of Transportation: Automated Vehicles 3.0, p. 13.
[37] *Id.*, p. 61.

obviously need a way to communicate with that vehicle to provide it instructions on where it needs to go and what it needs to do. These are not the dynamic driving tasks, but the operational use cases enabling ride sharing, car sharing, mobility on demand, personally-owned AV dispatch and recall, etc. Again, mobile broadband over 4G LTE and 5G networks is the natural communications method of choice for these uses.

The fourth way in which communications technologies will support AVs regards the human occupants of AVs. Already, in-vehicle infotainment is a substantial reason so many millions of conventional vehicles are equipped with cellular connectivity. In Level 4 and 5 vehicles, when there is no human driver required, the human occupants will have travel time to fill with other activities. All indications from the last two decades of the mobile industry suggest that they will want to consume productivity and entertainment content over mobile broadband.[38] Freed from conventional seating arrangements in a L4/L5 vehicle, as envisioned in many AV concept cars, there will be more ways in which the vehicle cabin itself can be used to provide access to such content.

[38] Data traffic on AT&T's mobile network has grown more than 470,000% since 2007, with video making up half of our mobile data traffic.

## CONCLUSION

Vehicle-to-anything communications, through the combination of short-range direct V2X and V2N capabilities, hold great promise in improving surface transportation safety, efficiency, convenience, and enjoyment. In light of the rapidly developing capabilities of automated vehicles and the growth of connected communities and smart cities technologies, V2X communications will only grow in importance in coming years. To rapidly achieve the benefits of V2X communications at scale, the Department should swiftly move to endorse a common communications protocol for short-range, direct V2X technology while continuing to encourage technology neutrality more generally. Failing to do so will delay the broad deployment of V2X technology and risk the reallocation of some or all of the 5.9 GHz spectrum to other purposes, greatly attenuating the potential public safety benefits of V2X communications. AT&T appreciates the opportunity to provide these comments on V2X technologies and we look forward to continuing to work with the Department and other stakeholders to advance the deployment and adoption of V2X communications.

Respectfully submitted,

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