July 27, 2018

The Honorable John Barrasso, M.D.
Chairman
Committee on Environment and Public Works
United States Senate
Washington, DC 20510

The Honorable Tom Carper
Ranking Member
Committee on Environment and Public Works
United States Senate
Washington, DC 20510

Dear Chairman Barrasso and Ranking Member Carper:

Enclosed please find responses to Questions for the Record following my appearance before the Senate Committee on Environment and Public Works on June 13, 2018.

Sincerely,

Shailen Bhatt
President and CEO
Intelligent Transportation Society of America

Cc:  Ron Thaniel, rthaniel@itsa.org
Chairman Barrasso:

1. Mr. Bhatt, the success of AV implementation is going to rely on a meaningful collaboration between government agencies and the private sector. What actions are industry leaders taking to anticipate and address the infrastructure needs required to accommodate AVs?

RESPONSE: Automakers and technology companies are designing and building automated vehicles to operate on existing infrastructure. These companies understand that America’s infrastructure is aging and increasingly outmoded. They are also aware of the funding challenges to improving our nation’s infrastructure. As a result, automakers and technology companies are designing and building automated vehicles that will integrate with human drivers and navigate diverse infrastructure conditions. For example, Intelligent Transportation Society of America (“ITS America”) Board Member General Motors is designing and building self-driving cars to safely operate among aggressive drivers, jaywalkers, bicyclists, delivery trucks, construction, unprotected left turns, 4-way stop signs and countless other factors that arise.

To optimize the performance of automated vehicles, road signage and lane markings should be maintained in a state of good repair and traffic signals and ramp meters standardized and connected. Well defined lane markings will not only help automated vehicles, they will also help human drivers more easily read them. Consistency for traffic control devices like road signs and traffic signals would also be helpful, with guidance from the Manual of Uniform Traffic Control Devices. Preparing for Vehicle-to-Everything (V2X) will provide an additional layer of information to the automated vehicle, to the pedestrian, and to the infrastructure. Advanced traffic management infrastructure, Vehicle-to-Infrastructure (V2I) communications, and Vehicle-to-Pedestrian (V2P) communications can reduce crashes, smooth traffic flow, reduce pollution, and most importantly, save lives. V2X communications in particular can support crash avoidance and driver assistance for road user categories that were particularly vulnerable to crashes, such as motorcycles, bicycles, and emerging unconventional systems such as electric scooters or robotic delivery drones that may share the road with conventional cars, trucks, and buses. Vulnerable road users such as cyclists can use V2X communications to actively signal their presence to conventional vehicles to avoid conflicts that can lead to crashes.

Society of Engineers (SAE) Level 1 systems (SAE J3016, Taxonomy and Definitions for Terms Related to On-Road Motor Vehicle Automated Driving Systems) like Driver-Assistive Truck Platooning also are designed to operate on today’s existing multi-lane, divided, limited-access
highways and require no new infrastructure or infrastructure changes. These systems improve the safety and efficiency of freight transportation by enhancing the teamwork between drivers while they navigate the roadway, allow traffic to enter and exit the highway, react to potential cut-ins, and coordinate lane changes. Pairs of platooning trucks will be able to navigate the roadway and interact with other traffic just as other trucks do today.

Safe deployment of automated vehicles will require a meaningful collaboration between government and the private sector. At ITS America, automakers and technology companies are collaborating with states and cities to plan for automated vehicles. Our members are at one table discussing legislation (Automated Vehicle Task Force led by Texas Department of Transportation and EasyMile), potential automated vehicle policies for the reauthorization of the FAST Act (Smart Infrastructure Task Force led by Regional Transportation Commission of Southern Nevada and HNTB), connected automated vehicle technologies (Vehicle-to-Everything Task Force led by Colorado Department of Transportation and Toyota), and cybersecurity (Cybersecurity Task Force led by AECOM and Metropolitan Transportation Commission San Francisco Bay Area).

Our members are demonstrating leadership and collaboration to ensure the safe testing and eventual deployment of automated vehicles. An example of this is ITS America former Board Chair and Michigan Department of Transportation Director Kirk Steudle. Under his leadership, the Michigan Council on Future Mobility was established. This council, established in state law, has a membership nearly equally divided between public and private sector membership with two chairs--one public and one private. Its charge is to provide policy recommendations to the state legislature and Governor on the development of technology involving autonomous, highly automated and connected vehicles. Other examples of public/private efforts are the automated vehicle testing facilities at the University of Michigan’s “Mcity” and the American Center for Mobility in Michigan.

Collaboration on automated and connected vehicle technologies and infrastructure starts with ITS America’s leadership. Our Board Chair is Carlos Braceras, Executive Director of the Utah Department of Transportation, and our Vice-Chair is Gary Smyth, Executive Director Global Research and Development Laboratories at General Motors. The ITS America Board of Directors includes AAA, Arizona Department of Transportation, California Partners for Advanced Transportation Technology at University of California Berkeley, California Department of Transportation, Conduent, Cubic, Delaware Department of Transportation, Econolite, General Motors, GRIDSMART, HELP Inc., Iteris, Kapsch TrafficCom North America, Metropolitan Transportation Commission, Michael Baker International, National Renewable Energy Laboratory, New York City Department of Transportation, Pennsylvania Department of Transportation, Qualcomm, Serco, Southwest Research Institute, State Farm Insurance, Texas A&M Transportation Institute, Toyota, Utah Department of Transportation, and Virginia Tech Transportation Institute.
Ranking Member Carper:
2. Early, high-profile crashes of autonomous vehicles have sowed public concerns and potentially distrust of autonomous vehicle technology. What improvements to the infrastructure necessary to support autonomous vehicle technology must occur in order to ensure that deployment of AVs builds public confidence? Specifically, what steps can the EPW Committee take to ensure that infrastructure helps to support the safe operation of these vehicles?

RESPONSE: Connected automated vehicle technologies are the best set of tools in our traffic safety toolbox to drastically reduce crashes. As we have seen over the past few months, technology is not infallible. While we must study each of these fatalities, we must not forget that every day on average in the United States, 100 people lose their lives on our roadways. Our members must redouble efforts to ensure any deployments of automated vehicles are safe. Private sector innovators — car and tech companies alike — along with research organizations, must work with government agencies to safeguard the public.

We need a federal framework for automated vehicle development and deployment, as well as reinforced state and local roles. We must allow these vehicles to drive the hundreds of millions of miles required to make them safer. Automated vehicles are much like new drivers — they have a great capacity to learn, but they need experience. Just as a human driver improves with time, so too will automated vehicles. Unlike humans, however, they do not get distracted, they won’t fall asleep, and they will not drive under the influence.

An important but overlooked part of awareness and confidence is that features of automated driving are advancing in the marketplace. Cruise control, an early example of vehicle automation, was first introduced in the 1958 models of the Chrysler Imperial, New Yorker and Windsor. Whether it is adaptive cruise control, parking assistance, lane integrity or rear object detection, current production vehicles are available with features that use safety technology to aid the driver.

As we prepare for automated vehicles, it may be instructive to look back at the FAST Act. Potential infrastructure capital costs associated with automated vehicle deployment, such as V2I, are already an eligible activity under the FAST Act. Recognizing that there could be infrastructure improvements that are not currently eligible, the ITS America Smart Infrastructure Task Force has been charged to complete a review and report back to ITS America leadership in 2019. If there are automated vehicle infrastructure improvements currently not eligible, ITS America will urge the Committee on Environment and Public Works to make these improvements eligible in the reauthorization of the law.

I previously referenced how poorly maintained roadway, bridge, and tunnel surfaces (buckled asphalt, potholes, etc.) can increase the risk of damaging vehicle sensors. Damage to sensors can compromise vehicle performance and may force a vehicle into a degraded state where automation must be deactivated. Poor surface conditions will decrease the vehicle's lifetime durability and increase the cost and complexity of operations and maintenance. Therefore, ITS America urges the Committee on Environment and Public Works to continue the FAST Act’s priority of bringing transportation infrastructure to a state of good repair in the reauthorization of
the law. I also want to reiterate that automakers and technology companies are designing and building automated vehicles to operate with existing infrastructure.

In terms of other specific policy actions for the Committee on Environment and Public Works, ITS America urges the Committee to maintain eligibility and funding for V2I communications equipment in the reauthorization of the FAST Act. We also urge the Committee to look at ways to incentivize states to use FAST Act funding to increase the deployment of V2I communications equipment. Due in large part to funding under the FAST Act, 29 states and 45 cities are deploying V2I communications that use the DSRC safety spectrum band to enhance safety, reduce crashes, and decrease fatalities. V2I deployments include expansions of the Safety Pilot Model Deployment in Ann Arbor (MI), large Pilot Deployments in New York City (NY), Tampa (FL), and Wyoming, and the Smart City Challenge in Columbus (OH). NHTSA estimates that safety applications enabled by V2V and V2I could eliminate or mitigate the severity of up to 80 percent of non-impaired crashes, including crashes that occur at intersections or while changing lanes.

It should be noted, however, that the Federal Communications Commission (FCC) seeks to allow unlicensed services supporting wireless consumer internet access in its current proceeding on the 5.9 GHz spectrum band, and final action in the proceeding may preclude some types of DSRC/V2X applications that have been described so far. Although supportive of sharing DSRC spectrum with Wi-Fi in principle, ITS America members are concerned that any regulatory action that reduces the effectiveness of DSRC could mean more unnecessary crashes, injuries and potentially deaths on our nation’s roads. We urge the Committee on Environment and Public Works to communicate to the FCC and U.S. Department of Transportation (USDOT) the importance of preserving the 5.9 GHz spectrum band for transportation critical safety communications.

3. Given that the House and Senate AV bills provide NHTSA with new exemption authority to permit thousands of AVs on the roads while also preempting states from regulating AVs, are there minimum infrastructure conditions, design changes, or Vehicle-to-Infrastructure connectivity policies that need to be established at the national level? Should these changes be implemented before widespread deployment occurs?

RESPONSE: Automakers and technology companies are designing and building automated vehicles to operate with existing infrastructure. While vehicle automation is likely to be supported by V2X systems, deployment of automated vehicles in the beginning is not dependent on V2X technologies. While establishing a national standard for V2V--as NHTSA was starting to do through its DSRC NPRM--would have quickly brought about broad industry adoption of a specific interoperable technology, some companies have moved ahead of the agency. ITS America members Toyota and Volkswagen have already committed to deploying DSRC V2X in Japan and Europe respectively. Toyota and General Motors have committed to deploy DSRC V2X in new cars over the next decade in the United States.
To optimize the performance of connected and automated vehicles while building intelligent infrastructure to compete in the 21st century technology-driven economy, upgrades to our nation’s infrastructure is needed. For example, we will need a 21st century, high-speed communications wireline infrastructure backbone, such as could support 5G along major transportation facilities to optimize vehicular communications. Though a national standard for a communications platform is an important component of ensuring that vehicles operate safely and efficiently across state lines, it is equally important to ensure that those infrastructure upgrades are in place to optimize deployment of connected and automated vehicles.

Congress could create a new program under the surface transportation law aimed at infrastructure upgrades in those areas that will be the testbeds for large-scale connected and automated vehicle deployment, or our nation’s most heavily traveled regions and trade corridors. These near-term improvements should have the dual benefit of immediately improving the operation of our nation's’ transportation system while also preparing it for connected and automated vehicle deployment. For example, the high-speed communications infrastructure backbone mentioned above will not just provide the basis for future vehicle-to-infrastructure communications but will also allow for the deployment of congestion-reduction technologies today such as current generation active traffic management, high-occupancy toll lanes, incident management and smart signal operations.

Additionally, from a transportation planning and policy perspective, how motor vehicles operate on public roadways have a significant impact on state and local abilities to make progress on their mobility, safety, performance, economic, environmental and social equity goals. As such, we believe that federal legislation should affirm the existing roles and maintain the balance of responsibilities between states, local governments, and the federal government in reference to the operation of automated vehicles.

4. In aviation and surface transportation settings, pilots and drivers must be certified to operate vehicles through a licensing process. Given the variation in how AV technologies operate and detect the roadside environment through probabilistic reasoning, should there be a similar licensing approach to certify that AVs are adequately prepared to detect the roadway signs, markings, infrastructural elements, and other users of the road? If yes, how so? If no, how might we otherwise ensure that in complex urban environments, for example, that highly autonomous vehicle technology is prepared to operate safely and effectively?

RESPONSE: Automotive innovation is occurring at a rapid pace and that innovation is advancing safety technology, including automated driver assistance systems, that help drivers avoid collisions. USDOT, under current and past administrations, wanted to encourage that innovation toward the goal of improved safety. There is variation in how automated vehicle technologies operate, which is how technology gets developed--different companies come up with different solutions to the same problem. An industry consensus approach and design for automated vehicle systems will emerge from iteration and evolving standards and best practices just as they emerged for past automotive technologies. A number of processes, checks and
balances are in place regarding the safe testing of automated vehicles, starting most importantly with a safety driver.

In addition, there are a number of industry standards and best practices for ADS-equipped test vehicles, including SAE J3018, Guidelines for Safe On-Road Testing of Level 3, 4, and 5 Prototype Automated Driving Systems (ADS). Manufacturers also conduct thorough simulation and closed-track testing, followed by real road testing with safety drivers. More generally, under the U.S. self-certification system for the regulation of automobiles, manufacturers must certify that any vehicle they put on the road must comply with all Federal Motor Vehicle Safety Standards (FMVSS) or that they have received an exemption from NHTSA determining the alternative means of meeting the standard is of an equivalent or higher level of safety. NHTSA continues to retain all of its enforcement authorities over the testing of automated vehicles on public roads, including random compliance testing of vehicles and recalling any vehicle or equipment it believes is unsafe. NHTSA has broad enforcement authority to investigate, penalize, and potentially mandate recalls involving automated vehicles. This is no different than its authority with respect to conventional motor vehicle components.

5. A significant number of roadway fatalities in this country occur on rural roads. One of the biggest challenges regarding the use of connected and automated vehicles is the lack of required infrastructure features to accommodate them in rural parts of the country. What can and should we be doing to prepare rural America for the expanded use of AVs?

RESPONSE: V2V communications technology can dramatically increase roadway safety, with the potential to eliminate 89% of Light Vehicle to Light Vehicle crashes and 85% of their associated economic costs. V2V technology is direct communication using the 5.850-5.925 GHz band (“5.9 GHz Band) between vehicles and does not require telecommunications infrastructure, such as cell towers, to function. The FCC allocated this 75 MHz of spectrum in 1999 for intelligent transportation services using DSRC and established licensing rules in 2004. Some automotive manufactures have begun or announced plans to deploy DSRC in vehicles. DSRC systems are designed to provide a short-range, wireless link to transfer information between vehicles and roadside systems. Recent advances in wireless communications technology have resulted in the development of Cellular-V2X (“C-V2X”) solutions that are being tested globally and utilize the 5.9 GHz band for direct V2V communications. Both DSRC and C-V2X can support the capability of V2I communications using the 5.9 GHz band. As automated driving systems continue to advance, combining them with connected-vehicle technologies holds the potential to dramatically reduce traffic fatalities and injuries and to improve throughput on existing roads.

V2I technology requires the installation of road side units to communicate with vehicles and communications infrastructure to enable highway operators to achieve situational awareness of roadway conditions. V2I will allow highway operators to provide information to drivers of road hazards, traffic conditions, or weather events. Many states have announced plans for deploying smart highway infrastructure on urban highways and rural roads. For example, the Colorado Department of Transportation (CDOT) plans to deploy 245 roadside units (RSUs) by 2019. By the end of the decade, more than 500 miles of state highways will be outfitted with RSUs to
support V2I communication. Many of these state highways are in remote rural and mountainous areas that are difficult to cover with reliable cellular communications networks. Moreover, CDOT has committed to ensure that as significant improvements are made to Colorado’s roadways network, the infrastructure needed to support V2I communication will be included in these projects.

ITS America believes deploying broadband infrastructure in conjunction with deploying V2I infrastructure could create significant synergistic benefits to rural America. Interstate highways located in rural areas are well suited for SAE level 1 systems like Driver-Assistive Truck Platooning (DATP), which are coming to market in the near term. Systems like DATP are designed to operate on existing multi-lane, divided, limited-access highways and require no new infrastructure or infrastructure changes. These systems improve the safety and efficiency of freight transportation by enhancing the teamwork between drivers while they navigate the roadway, allowing traffic to enter and exit the highway, reacting to potential cut-ins, and coordinating lane changes. Pairs of platooning trucks will be able to navigate the roadway and interact with other traffic just as other trucks do today. As part of ensuring the safe operation of driver-assistive truck platooning, system providers like Peloton Technology are using a combination of cloud-based monitoring and on-board sensors to only allow platooning on suitable highways and under appropriate weather and traffic conditions.

6. **Truck platooning could be one of the earliest forms of automation technology to be broadly adopted on our nation’s roadways. This technology allows trucks to run close to one another in a caravan formation. From an infrastructure perspective, this creates the potential for trucks to use roads more efficiently. On the other hand, bridges have been designed for greater spacing between heavy trucks, therefore more needs to be learned on whether bridge spans can safely handle the added weight. What research has been done into the impact that platooning could have on the structural integrity of our bridges? How many platooned trucks do you think most bridges could reasonably hold? Do you think there should be a limit to the number of vehicles allowed in a platoon in order to avoid this damage to our nation’s infrastructure?**

**RESPONSE:** From George Washington’s interest in canals and commercial waterways, the history of development in the United States has often been linked to advances in commercial transportation. Truck platooning offer an intriguing option for further efficiency in freight movement.

For the vast majority of bridges on multi-lane, limited-access, divided highways, based on analyses conducted to date, experts expect little to no negative effects when two-truck platoons are traversing them in comparison to existing non-platooning truck activity. Just last year, the Florida Department of Transportation (FDOT) conducted a highway bridge analysis and found fewer than one percent would have negative effects from two-truck platoons at a spacing of 30 feet between two 80,000-pound trucks. Based on the same FDOT analysis, no Florida bridges would have an issue with 60 feet between two 80,000-pound trucks.
Based on the standard formulas and rules for truck weight and axle spacing, even three-truck platoons at 60 feet following distances would present no issue for these and other bridges or other infrastructure on the U.S. highway system.

Today, in slower traffic, larger groups of conventionally-driven trucks (more than three or four) cross bridges at relatively close distances. As a result, platooning does not represent a major change to conditions that today’s infrastructure frequently handles.

For the more rare cases of highway bridges with special weight limitations, such bridges can be geofenced such that truck platoons open up spacing between the two trucks before crossing the bridge. In fact, since platooning systems can automatically increase spacing when crossing such bridges, this technology is better equipped to manage compliance than are conventionally driven trucks.

Truck platooning providers have also demonstrated the ability to specifically geofence other areas not suited for truck platooning such as toll plazas, construction zones, and any other special areas.

7. What should transportation planners begin doing now to accommodate AVs? How long will such planning and implementation require?

RESPONSE: Planners can be an important part of the dialogue with the public on the safety and mobility benefits for automated vehicles. The first step they can take is to become educated on the precise status of the technology and how it fits or conflicts with current infrastructure and other transportation assets. Second, they can offer a clear assessment at the practical local level of what changes are necessary to realize gains from the technology in terms of safety. Third, they can increase their collaboration with the technical staff at state and local agencies dealing with traffic signals, utilities and telecommunication to understand the planning implications. Finally, they can begin now to amend longer range plans to include of the potential for increased automated vehicle availability and travel. Even if these are simply presented as options, they will help raise the possibility and the potential benefits in the minds of policy makers and the public.

Connected autonomous vehicle fleets have the potential to deliver significant mobility, safety, economic and environmental benefits. For example, connected and automated vehicles could increase the capacity of roadways to ease congestion by less lost time at signals, smoother traffic flow on highways and shorter distances between vehicles. On the flip side, automated vehicles could increase the amount of vehicle miles traveled and, depending on whether or not zero-emission technology is deployed in conjunction with automated technologies, increase greenhouse gas emissions. Transportation planners should acknowledge this uncertainty and focus on prioritizing infrastructure projects, programs and policies that will be effective across multiple potential future scenarios.

ITS America Board Member Metropolitan Transportation Commission (MTC), the metropolitan planning organization for the San Francisco Bay Area, has recently undertaken Horizon, a new effort to plan for, and help shape, a range of possible connected and automated vehicle futures.
By expanding beyond traditional long-range scenario planning, which holds fixed certain transportation and land use assumptions, Horizon will help inform big questions facing the transportation industry, such as:

- Will connected automated vehicles substantially increase the vehicle capacity of existing highway lanes? If so, does it make sense to add additional physical capacity today?
- How might automation help solve the first-mile/last-mile transit challenge, reducing barriers to transit ridership? What type of investments are needed to get us there?
- What roadway investments could incentivize the shift to connected automated vehicles and expedite short-term safety benefits?

Ultimately, this effort could help planners analyze project performance across a range of different futures and lead to more informed project prioritization. Though the benefits may be significant, this planning effort requires substantial time and resources. Because it is a break from traditional planning, Horizon is a wholly separate effort that MTC will complete in advance of developing the region’s federally mandated Metropolitan Transportation Plan update. Additional federal planning funds and flexibility to experiment with innovative initiatives like Horizon could support transportation planners in efforts to maximize the benefits of connected automated technologies.

There are a large number of unknowns (some listed below) about how automated vehicles will impact the transportation system, but one of the most important unknowns is the timeline for broad automated vehicle adoption. Planners therefore need to start monitoring the impacts and trends as they emerge so that appropriate planning responses can be quickly developed as soon as long-term impacts can be confidently assessed. Transportation planners need to be flexible in their planning outlook, develop more scenarios and quantify the effect of each of the plausible outcomes. Instead of setting a rigid timing horizon, the planning efforts should be continuous and nimble and focused on achieving desired outcomes.

One approach that ITS America Advocacy Trust Member Regional Transportation Commission (RTC) of Southern Nevada anticipates taking is to develop a flexible roadmap that identifies “trigger points” for when key planning-related decisions about the future of the region’s transportation infrastructure need to be made. As the monitoring indicates that those important inflection points are approaching, the agency and its partners will be able to assess previous plans and ensure that the responses to the triggers are still appropriate and desired by the community. This approach should allow transportation planners to maintain a continuous, cooperative, and comprehensive planning process related specifically to automated vehicles and other emerging technologies.

Among the potential impacts of automated vehicles that transportation planners need to monitor and prepare responses for:

- Increased VMT due to relocation or circulation of empty vehicles, traveling to pick up other passengers, to avoid paying parking fees, or for other types of logistical reasons.
• Increased VMT due to reduced impacts of travel time inefficiencies. As automated vehicles allow drivers to spend time in the vehicle on other activities (entertainment, work, etc.), the time cost of driving will be reduced, which will generally result in increased vehicle travel.

• Increased VMT due to expanded land development. Because the travel experience in automated vehicles will be less demanding on drivers (potentially even giving them productive work time during the commute), they may be more willing to travel longer distances between work and home. If this trend emerges, it would probably trigger increased sprawling development to reach cheaper land further away from urban/suburban regions.

• Automated vehicles may decrease use of active travel modes like walking and bicycling. Similarly, to how riding in a car may become easier and more appealing, some people may be more inclined to let their car drive them to nearby destinations, rather than choose to walk or bike.

• As automated vehicle technology works into transit vehicles and drivers are replaced, the costs of operating those vehicles will probably decrease. This may create a windfall that could be applied to lower fares or service expansions, potentially increasing transit use.

• A future with wide automated vehicle adoption may transform the ways in which current components of the transportation system are used. For example, TNCs (Lyft, Uber, etc.) will require more access to curb space as they grow in overall use, which may result in different sidewalk and curb designs, different regulations about temporary loading zones, or even different revenue streams from “curb fees.”

• The need for extensive surface parking lots may be substantially reduced, as shared automated vehicles drop off passengers and leave for their next fares, or private automated vehicles relocate themselves to fringe areas with lower or no parking fees. If this trend materializes, parking areas in denser built environments (e.g., urban cores) could be converted to more productive uses and increase tax bases.

• Traffic congestion may be reduced if automated vehicles are able to operate more efficiently than conventional vehicles. Because automated vehicles may react faster than a human and be capable of operating safely with much smaller gaps between vehicles than human drivers may, road capacity could potentially increase. Current estimates of this additional “virtual” capacity range from about 50% to 400%. Such an increase in efficiency and traffic capacity of roads could potentially reduce the need for additional road or highway capacity (although other improvements to those facilities may be needed to achieve these capacity improvements). Over the long run, the need for some existing capacity may even decrease, potentially opening up right-of-way or current roadway areas for new and beneficial uses (e.g., parks, housing, etc.).

One important area that transportation planners need to immediately begin improving is the transportation modeling process, so that the models we use to determine whether, where, and when to add new infrastructure are effective at incorporating the wide range of potential traffic, behavioral, and economic changes that automated vehicles will bring.
8. In Japan, the Japanese government is leading testing of AVs, which is currently restricted to major limited access highways rather than on urban streets. In testimony for this hearing, we also heard from both the Wyoming Department of Transportation and New York City Department of Transportation about their implementation of a USDOT pilot program that explores connected vehicle application concepts within a limited, specific pilot sites for a finite duration. This allows the agencies to assess the impacts and evaluate the benefits. What are the pros and cons of taking what could be considered a more limited approach?

RESPONSE: Automated vehicles are being tested on public roads in limited Operational Design Domains (ODD) where local and states in cooperation with the localities and in conformance with any requirements. The model of automated vehicles will not be ubiquitous personally owned AVs anytime soon. Rather it will be the roll out of shared mobility fleets in those communities where extensive testing has occurred.

Senator Whitehouse:

9. As our vehicles move towards automation, this change will require that our infrastructure and roadways are updated to ensure that autonomous vehicles operate safely and efficiently. Upgrades could include well-marked lanes, accurate signage, and traffic lights that can communicate easily and clearly with autonomous vehicles.

a. What type of upgrades and investment should we be making now to our existing roadways and infrastructure to accommodate autonomous vehicles?

RESPONSE: Near-term investments in our transportation system should provide benefits across an array of different scenarios. One example of such a resilient strategy is investment in a 21st century, high-speed communications infrastructure backbone, such as broadband and 5G, along major transportation facilities. Robust communications will not just provide the basis for future vehicular communications but will also allow for the deployment of congestion-reduction benefits today through active traffic management strategies like high-occupancy toll lanes, incident management and smart signal operations. Demonstration projects should be funded in conjunction with these near-term investments to test how to maximize the co-benefits of improving existing operations of major arterial roadways and preparing them for future connected and autonomous vehicle fleets.

Connected automated vehicles should be tested in real-world settings in a collaborative process that includes state and local governments. This applied testing will help best identify the scope of infrastructure investments that will be needed to maximize the benefits and manage the impacts of connected and automated vehicle technologies across different types of roadways and operational contexts. It is important that such testing occur in metropolitan regions, as well as in less dense areas, given that connected automated vehicles will ultimately need to cross jurisdictional lines, transition from major arterials to local roads, and navigate buses, motorcycles, electric scooters, bicycles and pedestrians, and delivery trucks stopped at loading zones. Investments likely will include traditional transportation improvements like re-striping.
roads and upgrading signage along with investments in smarter infrastructure and data sharing technologies. For example, locals may need to share information on road closures, incidents and traffic signal operations with connected automated vehicles.

b. Should we be making changes to our infrastructure and roadways with the intention that the vast majority of vehicles in the future will be autonomous?

RESPONSE: Automakers and technology companies are designing and building automated vehicles to operate with existing infrastructure. We should be making changes to our infrastructure and roadways with the intention of benefitting all users, improving accessibility and mobility, and achieving a state of good repair for our infrastructure. We should prioritize strategies that will benefit users regardless of the ultimate level of connected automated vehicle penetration rates.

c. If electric vehicles make up the vast majority of autonomous vehicles, what type of infrastructure changes will we need to facilitate this transition?

RESPONSE: In addition to state of good repair investments in roadways and new communications networks, we will need zero-emission vehicle charging infrastructure and utility capacity in order to facilitate deployment of zero-emission connected automated vehicle fleets.

10. Transportation is now the largest source of carbon emissions in the United States, and carbon emissions from cars and light trucks account for almost one-sixth of the nation’s total emissions. We should be implementing policies in this sector with an eye towards reducing our emissions.

a. How can we design the right policies so that autonomous vehicles that enter our roadways are fuel-efficient and help us reduce our transportation emissions?

RESPONSE: Given the clear decision of developers and manufacturers to use electric or hybrid engines in automated test vehicles, it seems safe to say their actual deployment will contribute to emissions as well as safety and mobility policy objectives. The emissions and environmental benefits may be helpful selling points for a wary public unsure about “driverless” technology.

Federal, state and local governments could play a significant role in ensuring connected and autonomous vehicles are low-emitting. Policymakers could coordinate with utility providers to create blueprint and investment roadmaps for passenger, transit, and goods movement fleet charging and could consider incentives for investment in charging infrastructure to accompany other infrastructure improvements.

There is a natural synergy between automated vehicles and electric vehicles, ranging from compatibility in the power supply of electric drive technology with the electricity requirements for the additional vehicle hardware necessary for autonomous operations, to achieving weight, safety, and other co-benefits for vehicles specifically designed for electric drivetrains-related.
For automated vehicles to reduce transportation emissions, policies should be developed that encourage both the manufacturer and consumer use of automated vehicles that are powered by electricity. A wide variety of incentives for the manufacture of automated vehicles have been evaluated over the past decade and could be implemented.

b. Do we know how autonomous vehicle adoption will affect overall traffic patterns and the number of miles driven by cars? If not, what is the best way to study and better understand this?

RESPONSE: While connected and automated vehicle technologies should increase roadway capacity, they could also increase vehicle miles traveled. This is why we should consider travel demand management policies (including pricing on our highways, parking, and curb space) as well as standardizing data systems. Specifically, mobility could be improved through dynamic road pricing. Connected automated vehicle proliferation is likely to bring a multitude of new mobility services and demand to the road network. Vehicle trips could be subject to dynamic road pricing schemes like variable pricing in high demand areas (e.g., congested corridors and urban downtowns) and enhanced and increased express lanes. Not only will this fairly price mobility, it will also cause cascading effects such as encouraging more shared trips. Importantly, dynamic pricing requires real-time connectivity between vehicle or service operators and network operators. To establish secure, efficient connectivity for these purposes, data sharing standards and protocols will need to be collaboratively created.

It is also important to consider that preparing for a connected automated future does not just mean focusing on traditional passenger vehicles and roadways. The desired policy outcome should be to expand access to high-quality transportation, which also means a significant reinvestment in mass transportation with trunk line rail and bus upgrades (including considering appropriate connected and automated technology upgrades that could improve service efficiency and effectiveness), connected and automated microtransit services, mobility-as-a-service platforms, and new funding mechanisms to support investments.

If automated vehicles are widely adopted, but not electrified using renewable energy or car sharing fails to take off, greenhouse gas emissions and air pollution could actually increase. A study last year by University of California, Davis researchers projected that if vehicles are automated but not electrified or shared, greenhouse gas emissions from the transportation sector would go up 50 percent by 2050 compared to business as usual. However, if shared, electrified, automated vehicles flourish, greenhouse gas emissions could plunge by 80 percent, the study concluded.

For automated vehicles to work, transportation planning agencies should develop policies that promote ridesharing, encourage electric powered vehicles, and institute parking fees/reduction in the number of parking spaces per vehicle. Electric vehicles (EVs) have the potential to reduce emissions, while ridesharing can reduce VMT. However, if ridesharing doesn’t materialize but automated vehicles do, the result could be more traffic congestion, more vehicle miles traveled, and more emissions.
An important part of the development is commercial rather than technical. Developers need to explore what options and arrangements work for consumers and especially people who will share rides and vehicles. The pull of old habits for single-occupancy vehicle use remains strong, and new alternatives must be appealing and effective. There are numerous alternative scenarios for vehicle ownership and use. The benefits of reduced emissions and mitigating traffic congestion are easier to reach when individual drivers shift to shared ridership. Transportation planners need to be flexible, develop more scenarios and quantify the effect of each scenario’s possible outcomes.

Regarding truck platooning, SAE Level 1 (Driver-Assistive Truck Platooning systems are likely coming to market later this year, which will improve the safety and efficiency of freight transportation in the near term without the need for changes to today’s infrastructure or normal flow of traffic.

Truck platoon providers like Peloton Technology use linked safety systems to allow closer following distances between trucks, resulting in aerodynamic fuel savings. At 65 mph, fuel savings across a two-truck platoon are 7.25%, based on testing by the North American Council for Freight Efficiency – 4.5% for the lead truck and 10% for the follow truck. Along with “connected braking” – which bypasses delays in human perception and reaction time – a safe following distance of trucks in platoon is maintained by ordering the truck with the longer estimated stopping distance as the lead truck. This significant fuel savings is a win-win for fleets and the environment. Truck platooning can also deliver benefits for trucks with electric, hybrid or natural gas powertrains by providing range extension for these trucks – thus expanding the use-cases where fleets can make use of these types of trucks and accelerating the adoption of low or zero-emissions truck powertrains.

11. Reports suggest that the autonomous vehicle industry could expand into the trucking industry, e-hailing, and ride-sharing industry.

a. How soon can we expect widespread adoption of autonomous vehicles in these industries?

RESPONSE: Companies are on track to develop and produce fully autonomous vehicles for commercial use over the next few years. Time will tell how quickly these vehicles will be widely adopted.

b. How can we get ahead of the potential job losses that could occur in traditional trucking and ride-sharing industries if autonomous vehicles are widely adopted?

RESPONSE: Autonomous vehicles have the potential to reduce transportation and logistics operating costs for trucking, transit and the private mobility-as-a-service and delivery industries, improving efficiencies and adding to economic prosperity. However, automated vehicles could cause job loss for workers currently employed in trade, transportation, and utilities industries. It
is important to note that, much as smartphones introduced a wide range of previously inconceivable business models and disrupted decades-old industries, from cameras to calculators, connected and automated could introduce unforeseeable consumer products and services with a wide range of implications for the retail, service, and information industries. This economic shift could give birth to new industries with new opportunities.

Policy makers should consider targeting industrially-zoned lands for production, distribution, and repair. Once mainstreamed, the technology is likely to have an agglomeration effect, spurring other supportive industries like connected and automated vehicle production, distribution, and repair, all requiring physical space and resources. Local policy makers should work to ensure these trends benefit the whole community in part by zoning for manufacturing, distribution, and other industrial uses.

Lastly, government should be piloting connected automated vehicle applications that could spur new job opportunities. Even though much connected automated innovation is focused on the passenger economy, opportunities in goods movement are significant. Government agencies should launch competitions and support pilot programs in connected automated vehicle logistics, including sidewalk robots, drone delivery, modular urban logistics systems, and truck platooning.

c. Do we need to consider job retraining and workforce development policies to ensure that autonomous vehicle deployment does not disrupt the job markets for taxi, bus, and shuttle drivers?

RESPONSE: Training programs should be strengthened to expand opportunities for workers in the automated vehicle industry. As demand for drivers drops, thousands of workers may no longer be needed. In the interim, significant driver shortages are possible as workers retire, recruitment stagnates, and mobility demand continues to rise. Enhanced training programs could build skills in related growing fields such as customer service, data analytics, and specialized mechanics.

In addition, new investments in transportation, communications and zero-emission vehicle charging infrastructure will create near-term job opportunities.

The truck technologies coming to market today, such as truck platooning, are focused on using connectivity and advanced driver-assistance to improve safety, efficiency and mobility. These solutions do not displace driver jobs but instead improve driver jobs by helping them be safer and more productive. In the freight market today, fleets cannot find enough drivers to meet the growing demand. In a report from last year, the American Trucking Associations projected a driver shortage of 50,000 in 2017, increasing to almost 175,000 by 2026 under current trends. Anyone who wants to drive a truck today should have no problem finding a job and keeping it for decades, even with automated trucks starting to arrive in the market.
Even when large numbers of driverless trucks are on the road, there will be opportunities within the trucking industry for jobs that could pay more than drivers make today as well as new trucking-related jobs -- some already envisioned and others that no one has even thought of yet.

Truck automation will only enter certain segments of trucking operations over the next decades. Therefore, thoughtful projections show that increased truck automation can simply allow drivers to move from the hardest, least desirable jobs to healthier, better jobs.

A number of projections show that by increasing automation in trucking, the trucking industry could better handle skyrocketing freight volumes, which could lead to a net increase in total driver jobs -- with the most growth in more desirable local and regional haul driving. More and better driver jobs will exist in the future.

In the meantime, it is important for industry, drivers, and other stakeholders to have a meaningful dialogue about what the future holds. This should include a careful examination of how existing job training opportunities could help future drivers adjust to a world with AVs or what new training programs for the future workforce need to be developed and adequately funded.

A good first step is that industry leaders are beginning to study what a possible workforce of the future will look like, which will better inform the dialogue with the driver community and the public.

We know that over time, autonomous vehicles will change occupations in ways that require more skills and retraining. In the short term, the number of net jobs available will increase to support autonomous vehicle testing and fleet operations. We need to identify the new jobs that will be created, and industry has already started down this path. Several job classifications will not require a college degree, but training is critical. It will be important to coordinate with all levels of government to ensure technical and education programs align with the job needed to be done. Outreach efforts at the local level is key to getting the word out about new job opportunities in an automated vehicle era.

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