AMERICAN ASSOCIATION OF
STATE HIGHWAY AND
TRANSPORTATION OFFICIALS

AASHTO
THE VOICE OF TRANSPORTATION

TESTIMONY OF

THE HONORABLE KIRK STEUDLE

DIRECTOR,
MICHIGAN DEPARTMENT OF TRANSPORTATION

ON BEHALF OF

THE AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS

REGARDING

How Autonomous Vehicles Will Shape the Future of Surface Transportation

BEFORE THE

SUBCOMMITTEE ON HIGHWAYS AND TRANSIT
COMMITTEE ON TRANSPORTATION AND INFRASTRUCTURE
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American Association of State Highway and Transportation Officials♦444 North Capitol Street, N.W., Suite 249, Washington, D.C. 20001♦202-624-5800

Introduction

Chairman Petri, Ranking Member Norton, and Members of the Subcommittee, thank you for the opportunity to share the American Association of State Highway and Transportation Officials'.(AASHTO) views on autonomous vehicles and how they will affect the future of transportation. My name is Kirk Steudle and I am the Director of the Michigan Department of Transportation. I am also a current member of the AASHTO Board of Directors and past President of AASHTO. Today I am proud to testify on behalf of AASHTO, a non-partisan, non-profit association that represents the State departments of transportation (DOTs) of all 50 states, Washington, D.C. and Puerto Rico, which will be commemorating its 100th anniversary in 2014.

First of all, I would like to thank you, Mr. Chairman, and this subcommittee for your role in the development of national surface transportation policy, which contributes greatly to the improvement of highway and transit facilities across the country, the implementation of critical transportation safety and research programs, and the regulation of commercial motor vehicle operations. It is therefore very logical that this committee would bring forth a topic that speaks directly to the future of our transportation system – and the not-too-distant future, at that – autonomous vehicles.

Numerous research consortia, academic institutions, government agencies, and private sector industries are working on various aspects of bringing to life a viable driverless vehicle. No longer the work of science fiction, a fleet of autonomous vehicles will, in all likelihood, be driving our roads and highways in our lifetime. The benefits will be numerous: a significant reduction in crashes and the associated deaths and injuries; greater efficiencies in the use of our limited infrastructure; and increased mobility options for underserved communities such as the elderly and disabled, not to mention many benefits we presently cannot begin to predict.

The Big Picture

I believe it is best to start my testimony today with a view of the big picture of autonomous vehicles and how they will change our lives and affect the way we travel. In reality, autonomous vehicles are a means to achieving the larger goal of a modern society which maintains and operates the safest and most efficient transportation system possible. It is clear that autonomous vehicles have the potential to help us reach this bigger goal. We in the transportation industry can now envision a future with accident-free vehicles; vehicles that can at times drive by themselves; and vehicles, drivers, and transportation infrastructure that are connected safely and securely for reliable information sharing.

To reach this ultimate goal, many years of research, testing, and evolution of vehicles, technology, and infrastructure will have to take place. And this evolution will include a wide range of enabling technologies and opportunities, from sensor-based information to wireless communications between vehicles and vehicles with the infrastructure, and other technologies we haven't even thought of yet. We do not want to limit our options or reduce the possibilities of what research and technology could produce in the next 5, 10, or 20 years – We must look at all options and combinations of options for achieving this tremendous vision of safety and mobility in the future. It will undoubtedly take time to achieve the vision we set out today as technology becomes refined and accepted by consumers. New vehicles typically represent approximately 6-7% of the total automotive fleet; consequently, a typical market penetration curve would reach 50% of the vehicle fleet in 7 to 8 years, assuming all vehicles are to be fully equipped and no unforeseen events disrupt market adoption. Therefore, decisions that we make must consider the evolutionary process that will take us from the grand visions of today to the realities of tomorrow.

The Benefits

It is exciting, however, to think about the possibilities that connected and driverless vehicles present, none of which is more important for human society than potential safety benefits. 5.3 million police-reported vehicle crashes occurred in the United States in 2011, resulting in about 32,000 fatalities and more than 2.2 million injuries. According to a 2008 National Motor Vehicle Crash Causation Survey conducted by NHTSA, around 90% of all crashes have some human contribution attached. Currently, crashes can only be avoided by what the driver can see. Humans are unable to see around the corner of a building, over the crest of a hill, or past a large obstacle such as a freight truck, among others. If we take the driver out of the equation and replace him with sensory and communications equipment capable of "seeing" and "talking to" other vehicles and the infrastructure – especially those that cannot be seen by the naked eye – we have the potential to reduce vehicle crashes significantly. Examples of some of the safety technologies include:

- Warnings of potential crashes before they happen (either through sensor technology for vehicles within sight or short-range communications for hazards that are not visible to the driver)
- Avoidance technology to steer away from or around an obstacle
- Automatic braking to react more quickly than humanly possible
- Extended green or yellow time on traffic signals if approaching too quickly to stop
- Traffic signal override to give emergency vehicles the green (currently possible for ambulances, police, fire)

Data in a 2012 NHTSA Fatal Crash Analysis survey shows that more than 40% of fatal crashes involve alcohol, distraction, drug involvement, and/or fatigue. At the very least, fully autonomous vehicles, if realized, can make up for human failings of this nature. Connected-vehicle technology, itself, (which involves communication between vehicles and with the infrastructure), has the potential to mitigate up to around 80% of unimpaired crashes, according to a study by KPMG and the Center for Automotive Research.

At some point in our lives, a majority of us will be disabled in one way or another, whether it is temporary due to injury (such as a broken arm or leg) or more permanent, such as from a disease (Parkinson's, epilepsy, etc.). Many of us have already experienced being driven to and from school or work, doctor's appointments, or running errands. An autonomous vehicle, even with just a few technologies, could significantly improve mobility for those who are temporarily or permanently disabled by reducing or eliminating their reliance on outside assistance for transportation. This, in turn, could reduce the need for "demand-response transit" and other services that are currently provided by governments across the country. It should be noted, however, that current technology has its limits and states that have already enacted laws related to driverless vehicles (including California, Nevada, and Florida) have mandated that drivers be able to take over control of the vehicle should it be required.

In addition, if we are fortunate enough to live past retirement age, we will be senior citizens with vehicle needs that go beyond the typical driver. Transportation professionals and the automobile industry are already accounting for the "baby boom" generation's aging (including such things as reduced reaction times and physical mobility) by increasing the size and legibility of road signs and providing in-vehicle assistance such as back-up cameras and brake assistance. Autonomous vehicles will provide increasing mobility options to our aging population.

It is not just vehicle operators who will see benefits of safety improvements. Pedestrians, cyclists, and motorcyclists could enjoy safety benefits assuming the technology can one day be equipped to detect sizes and shapes of different "obstacles." Finally, American society stands to save not just lives, but dollars as well. A study by a UT-Austin researcher projects a $17.7 billion, $158.8 billion, and $355.4 billion dollar comprehensive cost savings from a reduction in crashes in scenarios with 10%, 50%, and 90% market penetration rate, respectively.

We stand to see benefits from increased mobility and efficiency as well. The reaction time of a human driver is significantly slower than that of a computer – 2.5 seconds for perception and then reaction to an event is typical – so both safety and mobility can be improved with the addition of computerized systems in vehicles to assist in the driving task. Because cars will be able to react to each other more quickly, they will be able to drive closer together, allowing the transportation systems to operate more efficiently with fewer slow-downs caused by crashes and sudden movements, all while increasing the number of vehicles per lane-mile. To put this in numbers, the Urban Mobility Report prepared by the Texas A&M Transportation Institute indicated that congestion in 498 urban areas during 2011 accounted for 5.5 billion hours of extra time and 2.9 billion gallons of wasted fuel at a cost of $121 billion annually. The cost to the average commuter was $818 in 2011. To slash these numbers would add significant economic activity into the American economy and make both passenger- and freight-travel more efficient.

The System of the Future

Let us now get back to grand picture. As we look to the future, we see a more automated and seamless transportation system interacting daily with a drastically different society. In 20 years, the influx of advancements in sensor technologies and the beginning of interconnected communications between cars, infrastructure, and the surrounding environment will start to make a sizable dent in the number of crashes, injuries, and fatalities occurring on our highways. It will also reduce congestion by allowing cars to travel closer together, and improve the mobility of citizens who depend on transportation to get them from point A to point B. Fifty years from now, an interconnected fleet of vehicles, interacting with each other as well as with the infrastructure, and connected seamlessly to other modes of travel including high-speed rail, aviation, and transit, could take you – on verbal command – from your origin to your destination without incident and without a driver. The vehicle you use might be subscription-based, and you would have access to whatever style of vehicle you need for the trip you are making – whether single-occupant commuting to work, vacation with the family, or trip to Home Depot.

It is also entirely possible that the way we design and build transportation infrastructure could change dramatically. With potentially "crash-less" cars, the need for extra-wide lanes, guardrails, rumble strips, wide shoulders, even stop signs could decrease exponentially. The footprint transportation would leave on the environment would be reduced and decreases to costs would be very noticeable. Even conservative estimates of a 10 percent reduction in infrastructure investment would result in billions of dollars in savings to users and taxpayers. A recent research study showed that based on a 10% discount rate, annual comprehensive costs savings are estimated to be $37.6 billion, $206.8 billion, and $434.7 billion for a 10%, 50%, and 90% market penetration, respectively, while comprehensive cost savings per autonomous vehicle would be $3,120, $4,580, and $6,680 for the same penetration rates. When looking at the net present value of automated vehicle benefits, minus the purchase price, one sees comprehensive cost savings of $13,730, $29,840, and $47,810, based on those same penetration rates. If these figures are even close to accurate in the future, it will represent a fundamental change in the economic footprint left by the transportation sector and will make our society more modern, more interconnected, and safer than ever before seen on wheels.

Challenges

The technology of both autonomous vehicles and connected vehicles/infrastructure are not without its challenges, unknowns and implications. First, with more people being able to drive, potentially significant increases in wear and tear on infrastructure could occur, albeit possibly tempered by lighter vehicles, which could counter the decreases in infrastructure expansion that I mentioned previously. In any case imaginable, especially given our current aging infrastructure, infrastructure investment will need the full-attention of policymakers in the coming years. This is not even mentioning the investment needed to equip vehicles and to retrofit pieces of roadway infrastructure with technologies or higher grade materials to accommodate autonomous vehicles, regardless of the technologies used. For example, sensor-based systems will need assurances of well-maintained or even more reflective pavement markings and traffic signs that are readable by computers, while communications systems will need periodic signal repeaters along the roadway corridors. We need a fuller picture of these potential scenarios and related costs to come up with a precise analysis of the benefits and costs so, at the very least, those who work on our transportation network can more accurately plan for the future.

Another pressing challenge will be on the legal front when discussing liability, licensing, and regulatory issues. If autonomous vehicles and connected technology become more prevalent, states will be pressed to develop regulations and policies to accommodate the changing landscape. How quickly the technology develops will determine how quickly states may need to pass the legal and regulatory framework necessary. Some issues will include liability for potential accidents, insurance regulations on autonomous vehicles, and overarching federal mandates on future technologies.

Security and privacy will also become larger issues, as well, relative to the development of this technology. We as Americans have already started conversations on the privacy and security of this type of data. However, when the data are coming from something as personal as an automobile, privacy and security issues become paramount. Data sharing could prove problematic for those who do not wish to have their private lives out in the open. Questions have already been posed by researchers and will need to be answered in the coming years regarding what data will be shared, with whom it will be shared, in what way will it be made available, and for what ends will it be used. Also, could cars be hacked? Disruption via viruses could cause nationwide disruption to the transportation system, which would devastate the economy and all segments of society. Risks of such an attack would have to be mitigated so as to protect the well-being of those in the transportation network and the infrastructure investment.

A challenge that is specific to the connected vehicle program and the safety applications that are being planned to prevent crashes is the need for fast and secure communications—faster than currently available with traditional cellular communications. Dedicated short-range communication (DSRC) is uniquely suited to this type of safety application because it provides fast network acquisition, low latency, high reliability, priority for safety applications, interoperability, security, and privacy. AASHTO, U.S. DOT, and numerous automobile manufacturers have been specifically researching this complex matter. To test this technology, US DOT is sponsoring a pilot test called the Safety Pilot Model Deployment (Safety Pilot), which is being conducted by the University of Michigan Transportation Research Institute and is taking place in Ann Arbor, Michigan, from August 2012 to February 2014. The primary goals of this pilot are to test the effectiveness of vehicle-to-vehicle technologies in real-world situations and to measure their potential benefits. Tests involve:

- hardware to send and receive data among vehicles,
- software applications to analyze data and identify potential collisions,
- vehicle features that issue warnings to drivers of these potential collisions, and
- a security system to ensure trust in the data that are being communicated among vehicles.

In total, about 2,700 passenger vehicles are equipped with these technologies in order to participate in the Safety Pilot. Due to the potential to positively transform highway safety, NHTSA is considering requiring DSRC communication technology on new cars in the future, and a decision is expected in the next month or so.

There are deployment issues to confront as well. The potential benefits of vehicle-to-vehicle technologies, vehicle-to-infrastructure technologies, and autonomous vehicles are dependent upon a number of factors including: their deployment levels; how drivers respond to warning messages; and the deployment of other safety technologies that can provide similar benefits. According to USDOT, the safety benefits of vehicle-to-vehicle technologies will be maximized with near full deployment across the U.S. vehicle fleet, but that does not mean that benefits will not be realized in the interim. Even if NHTSA pursues a rulemaking requiring installation of these technologies in new vehicles, it could take a number of years until benefits are fully realized due to the rate of turnover of the fleet. According to one automobile manufacturer interviewed by GAO, given the rate of new vehicle sales, it could take up to 20 years for the entire U.S. vehicle fleet to turn over.

There are also a number of issues that State DOTs will have to confront over the coming years as connected vehicle technology and automated vehicles become more commonplace. We as an industry will have to determine the necessary performance expectations of roadway infrastructure to adequately support the technical needs of driverless vehicles and how these increased performance requirements will be funded. It is also prudent and necessary to think about the interim timeframe when both potentially autonomous and non-autonomous vehicles will be on the roadway. Higher retro-reflectivity of signs and pavement markings and added transition zones for engagement and disengagement of autonomous features will be needed in a mixed scenario before the fleet and the infrastructure is fully switched over. In addition, recovery zones may be needed should a vehicle cease to function properly or a driver fails to re-assume positive control of an autonomous vehicle. These are just a few examples of the potential infrastructure upgrades that will need to be studied in fuller detail.

Michigan Experience

The Safety Pilot Model Deployment, as well as other connected vehicle test bed activities undertaken in Michigan, has provided insight into what we can be prepared for as new technologies are adopted into our transportation system.

One of the critical areas for success of the deployment of these advanced systems is the interoperability of the technology between different makers of field and automobile systems. The success of the Safety Pilot in Ann Arbor has shown that this level of interoperability is most definitely achievable; this level of focus will have to be maintained in order to ensure functional, safe systems regardless of who makes these systems, and regardless of where in the country they are used.

We talked about the challenges of data privacy before. One thing we have found is that these systems are generating massive amounts of data – as a matter of fact, more data than we expected when we first began deployment efforts. With this influx of "Big" data, the need for ensuring the privacy of the data and the data generators, and the ability to process it into useable information, becomes focused much more into the center stage.

These new technologies and amount of data also present an additional challenge for most transportation agencies across the country. This technology requires a set of skills to develop, operate and maintain that traditionally haven't been associated with public transportation agencies. Agencies will need to be flexible in developing and recruiting a workforce with the advanced technological skills needed to develop, operate, and maintain these sophisticated hardware and software networks.

Recommendations

So, how do we go forward from here? There are several recommendations I would offer to this committee and the Congress on how to most effectively prepare for this sea-change in the way surface transportation functions.

The first will be to encourage NHTSA to make a decision on vehicle requirements later this year. NHTSA is planning to announce further actions it will take regarding connected vehicle technologies for passenger vehicles, including potentially announcing intent to pursue future regulatory action such as a proposed rulemaking to mandate the installation of vehicle-to-vehicle technologies in newly manufactured passenger vehicles. The 2013 NHTSA decision will determine the future of connected vehicle technology for safety. If NHTSA pursues a rulemaking on safety applications, vehicles equipped with dedicated short-range communications (DSRC) may begin rolling off the production line in late 2019. These vehicles would broadcast information such as their location, speeds, and direction of travel through the high-speed communication of DSRC. How quickly this technology moves forward will depend greatly on this very important decision. Having resolution here is critically important.

It is also necessary to protect the DSRC's 5.9 GHz spectrum for the connected vehicle program and ensure that the possible sharing with other wireless users of the radio-frequency spectrum used by vehicle-to-vehicle communications will not adversely affect the technology's performance. This spectrum provides us the most promising attributes necessary for connected vehicle/infrastructure technology. The President and Congress have responded to growing demand for wireless broadband services by making changes in the law to promote efficient use of spectrum, including the band previously set aside for use by DSRC-based technologies. We would urge that the Congress be prudent about this specific spectrum since it may be critical to the success of the connected vehicle and infrastructure technology.

Finally, there are several measures that can be taken during the next round of Surface Transportation reauthorization. The Congress has the potential to make significant strides with this new technology depending on measures placed in the reauthorization of MAP-21. Additional funding for research is necessary to more fully understand the breadth of possible operating scenarios and implications that autonomous vehicle technology and connected vehicle/infrastructure technology will have on society. These include studies on market penetration evaluations, transition issues with mixed fleets of autonomous and non-autonomous vehicles, performance and system reliability issues, changes to travel demand patterns, alterations to vehicle-miles traveled and vehicle emissions, integrated automated vehicle and intelligent transportation systems (ITS) infrastructure investigations, and potentially necessary federal mandates to operate a seamless automated system in the future.

Your support is also sought in continuing the collaboration that has been underway for several years between the USDOT, State DOTs, and global automakers. The cooperation between these three entities might very well determine the success of these technologies and their potential integration into the transportation system. One such example could be support for the Center for Operations Excellence, which is being jointly developed by AASHTO, the Institute of Transportation Engineers (ITE), ITS America and FHWA. The Center will be able to help address implementation issues with the conversion of connected vehicle/infrastructure and autonomous vehicle technologies. This venture, which is being established now, will be funded and jointly operated by AASHTO, ITE, ITS America, and FHWA and could serve as an important tool for governments in their transition to more autonomous transportation systems.

Chairman Petri, I once again thank you and your committee for allowing me to speak on this very exciting and important development in the transportation industry. Surface transportation has been drastically changed with the advent of computer technology, and automated and connected vehicles stand as the next stepping stone toward our goal of delivering a safer, more efficient transportation system for our country. I will be happy to answer any questions the committee might have.