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THE ROAD AHEAD: ADVANCED VEHICLE TECHNOLOGY AND ITS IMPLICATIONS

HEARING

BEFORE THE

COMMITTEE ON COMMERCE, SCIENCE, AND TRANSPORTATION UNITED STATES SENATE

ONE HUNDRED THIRTEENTH CONGRESS

FIRST SESSION

MAY 15, 2013

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SENATE COMMITTEE ON COMMERCE, SCIENCE, AND TRANSPORTATION

ONE HUNDRED THIRTEENTH CONGRESS

FIRST SESSION

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THE ROAD AHEAD: ADVANCED VEHICLE TECHNOLOGY AND ITS IMPLICATIONS

WEDNESDAY, MAY 15, 2013

U.S. SENATE,
COMMITTEE ON COMMERCE, SCIENCE, AND TRANSPORTATION,
Washington, DC.

The Committee met, pursuant to notice, at 2:40 p.m. in room SR–253, Russell Senate Office Building, Hon. John D. Rockefeller IV, Chairman of the Committee, presiding.

OPENING STATEMENT OF HON. JOHN D. ROCKEFELLER IV, U.S. SENATOR FROM WEST VIRGINIA

The CHAIRMAN. Mr. Strickland, I apologize.

Mr. STRICKLAND. No apologies, sir. This is your forum.

The CHAIRMAN. John Thune was here on time. He is from South Dakota, and they have got good values.

[Laughter.]

The CHAIRMAN. We have good values in West Virginia, but just evidently today, a couple of them passed me right by, so I apologize.

The story of modern America would be difficult to tell without the automobile. Ever since the Model T first rolled off the assembly—that should say assembly line, should it not? You cannot walk off an assembly.

[Laughter.]

The CHAIRMAN.—the car and its drivers have shaped our history, our lives, and our imagination. It was the automobile, after all, that brought forth Detroit's rise. The golden age of manufacturing, it gave Americans a new sense of independence and freedom. It changed quite literally our country's landscape. The car has been a defining ingredient in modern American culture.

The automobile has also been central to the story of America's innovation and public safety standards. Seat belts, brake lights, air bags have saved innumerable lives that were once needlessly lost. Today the cars on our roads are safer than ever, but we still have a long way to go.

More than 30,000 lives are lost each year—I can remember when that was 50,000. I can remember when that was 50,000, so that's good, but that is an awful lot of lost lives—each year on our highways and roads. Most crashes frankly are caused by driver error. That needs to be said. Automakers, regulators, researchers must continue their pursuit of safer vehicles and fewer fatalities, especially at the hands of driver distraction, impairment, or poor judgment. In recent years, I have seen advances in vehicle technology

that show great potential, not only to save the lives of many more, but also to revolutionize how we have come to understand the relationship between the driver and his or her car.

Driver-assist technology has already found its way into some of today's cars. Electronic—and they will get to Florida in due time—electronic stability control, for example, prevents rollover accidents and is now installed in all new cars, saving hundreds of lives per year. The latest sensors, cameras, and software are doing even more to assist drivers. They can warn the person behind the wheel of an imminent crash. If the driver does not respond, the car will stop itself. They can warn drivers if the vehicle is drifting into another lane, and can even automatically bring the car back to its proper place. Another system knows when the driver's eyes wander off the road and can alert him back, or her, back to the task at hand.

So the power of technology is already saving lives, but looking ahead a bit further down the road, the car's future is even more incredible. Advanced technologies currently under research and development could radically challenge our notion of what it means to be behind the wheel. One of these technologies enables vehicles to communicate with each other and with the road, warning drivers of dangers ahead that they have no way to see. Another technology, of course, is one all of us have heard about, that is, the self-driving car that could take you safely from point A to point B with no human involvement.

There is much to be excited about as these technologies develop, but there are risks as well. As important questions, we have to ask some of them this day and discuss them. One growing technology raises concerns for me, and that is auto makers seem to be engaged in a race of sorts to see who can add more entertainment and communication devices and features into the car's dashboard, all in the name of allowing drivers to remain connected. I am not convinced so many of these devices are necessary, and I fear they only further distract drivers. We can discuss that.

Even those technologies with great potential, safety benefits, come with their risks. As our cars become more computerized and electronics-based, can the industry make sure that they are reliable and prevent failures? And as our cars become more connected to the Internet, to wireless networks, with each other, and with our infrastructure, are they risk for catastrophic cyberattacks? In other words, could some 14-year-old in Indonesia figure out how to do this and just shut your car down—shut a whole bunch of cars down because everything is now wired up? And this is one of the, you know, results of the Internet. You connect things enough, you can cause things to stop happening. Now, that potentially will at some point include automobiles.

And as our cars become more computerized and more electronic based, can the industry make sure that they are reliable and prevent failures?

So we have so much change in automobiles and at such a rapid clip. It is like people are competing with each other to titillate, tantalize, and it sells. It works. This is not of particular interest to anybody, but I am a great fan of Johan Sebastian Bach, and I listen to him when I drive to work, and I listen to him when I go

home. But in order to listen to him, I've got to push all kinds of things. And if you have noticed traffic recently in Washington, D.C., you do that for a second, and you have moved a half lane over. You did not mean to, but you just have because you've got to do this, and you've got to do this, and you've got to do that. And that is a simple one.

I think this hearing is going to provide us with an overview of what the future holds for our cars, it will give us a foundation for future legislation if necessary and for future industry oversight as we move forward. If they deliver as promised, the technologies we are discussing today have the potential to revolutionize transportation and bring about dramatic improvements in safety.

And I thank you, and I turn to my distinguished Ranking Member, Senator Thune.

STATEMENT OF HON. JOHN THUNE,
U.S. SENATOR FROM SOUTH DAKOTA

Senator THUNE. Thank you, Mr. Chairman. I will be watching for you, listening to Bach when I am driving in in the morning.

[Laughter.]

Senator THUNE. I want to——

Senator NELSON. Watch for him when he punches the devices. [Laughter.]

Senator THUNE. I want to want to thank you, Mr. Chairman, for holding this hearing as the Committee examines a variety of advanced motor vehicle technologies that are now emerging in the marketplace and working their way through the product development pipeline. These technologies, which include driver assistance systems, vehicle-to-vehicle communication, and autonomous self-drive cars, offer the promise of many future benefits.

Advanced driver assistance technologies, such as adaptive cruise control, collision avoidance, and lanekeeping systems appear to offer obvious safety benefits. In addition, these technologies, many of which are being developed domestically, represent innovations that will help to drive the tech and manufacturing sectors and benefit our economy. It is very welcome news to hear NHTSA report that traveling by vehicle has become safer in recent years. According to the agency, fatality and injury rates reached new lows in 2009 compared to 10 years ago.

I hope we will continue to improve in this area, and I am encouraged by new technologies that offer the promise of an even safer driving experience. One such advancement is the Department of Transportation's Intelligence Transportation Systems Program, better known as ITS. In 1999, the Federal Communications Commission allocated spectrum in the 5.9 gigahertz band so that vehicles can someday communicate wirelessly with each other and with their surroundings. This connected vehicle's technology holds tremendous potential to make driving much, much safer.

Last year, Congress directed the National Telecommunications and Information Administration to study whether wireless Wi-Fi devices could share the same 5.9 gigahertz spectrum band as the ITS technology. Expanding Wi-Fi use in the five gigahertz range is becoming more important as other Wi-Fi bands have become extremely congested.

Advocates of connected vehicles, however, have raised concerns that Wi-Fi use in the 5.9 band will interfere with ITS, which could, in turn, endanger drivers. While some people have characterized this as two technologies pitted against each other, I instead choose to see this as an opportunity. Connected vehicle technology and increased Wi-Fi bandwidth will each have significant benefits for the public. Obviously, the best possible public policy outcome is if the engineers can find a way for both technologies to coexist in the 5.9 gigahertz band. The NTIA and the FCC are currently examining whether such spectrum sharing can be accomplished, and we should avoid letting heated rhetoric color this debate while we await the findings of the technical experts.

Americans have long marveled at the notion of an autonomous vehicle, a car that could drive itself. Anyone who has seen the You Tube video of Steve Mahan, a blind man, using a Google self-driving car to perform his daily errands around the suburbs of Morgan Hill, California, knows how potentially life-changing these technologies may be. These self-driving cars offer a glimpse into the future.

Mr. Chairman, maybe our next hearing on the subject should take place at a test track in West Virginia or South Dakota so we can more directly explore the vehicle technology of Google and others, which undoubtedly will build upon today's discussion.

I am pleased that we are joined today by NHTSA Administrator Strickland. As a Federal agency within the Department of Transportation responsible for highway traffic safety and motor vehicle safety standards, NHTSA must partner with industry to make the high tech cars of the future a reality.

In the NHTSA reauthorization passed last year as part of MAP–21, Congress directed NHTSA to establish a new council for electronics and emerging technologies to improve the agency's expertise in the areas being discussed at today's hearing. I am particularly interested to learn more about NHTSA's plan for tackling its mission to ensure safety, while also ensuring that innovation is not stifled.

The potential benefits of these advanced motor vehicle technologies are remarkable. They should enable advanced safety features, new information services, greater energy efficiency, and reduced insurance risk, and provide a growing market in our economy. However, with these advancements, Congress, regulators, industry, and other stakeholders must grapple with the forward-looking questions that will shape the motor vehicle technology landscape in the coming years.

What changes to the Federal motor vehicle safety standards, if any, are necessary to ensure that automobile manufacturers can safely adapt new technologies and bring them to market? Do the motor vehicle technologies currently in the pipeline present other risks that we should be aware of, including driver distraction, cybersecurity, and privacy risks? And how are product developers working to identify these risks in order to engineer mitigating solutions? Does NHTSA have the necessary expertise in order to perform properly its mission in this area?

I know the Committee looks forward to hearing from the witnesses on these issues today, and I want to thank you for being

here and for sharing your testimony. And again, thank you, Mr. Chairman, for calling this hearing.

The CHAIRMAN. Thank you, Senator Thune.

And the Honorable David Strickland, who is the Administrator of the National Highway Traffic Safety Administration, we are very glad that you are here. You have a large job. There is a whole slew of issues, some of which we have mentioned, and many of which we have not. So we will be interested in your testimony, and then we will want to question you about it.

STATEMENT OF HON. DAVID L. STRICKLAND, ADMINISTRATOR, NATIONAL HIGHWAY TRAFFIC SAFETY ADMINISTRATION

Mr. STRICKLAND. Well, thank you, Mr. Chairman. But before I begin my remarks, I would like to introduce NHTSA's new Deputy Administrator. The President appointed him, and the Secretary swore him in this morning, David Freeman, on my left. Wave to everybody, David.

The CHAIRMAN. He raised his right hand.

[Laughter.]

Mr. STRICKLAND. Again, thank you so much for the opportunity, Ranking Member Thune, Mr. Nelson, Mr. Johnson. This is a real opportunity for the agency to talk about a very exciting time in the automobile industry. We have been focused on crash worthiness for over 40 years, frankly since we have been in the business, since 1966. And these technologies that you both alluded to in your opening statements really are the new North Star for the agency.

As opposed to just protecting people in a crash, how can we keep the crash from ever happening? And that is such an important opportunity for us to make that critical disruptive change to make sure we get well below 30,000, 20,000, 10,000 lives possibly in the future.

So we feel at the National Highway Traffic Safety Administration, that the future for the automobile is extremely bright. Increasingly, a car's capabilities are determined more by electronics than by mechanical linkages. This is bringing countless innovations that improve driver comfort, provide information and entertainment, and, most importantly, advance safety. According to early estimates, there were over 34,000 fatalities on America's roadways in 2012, and I believe the advanced safety technologies that we are discussing today could reduce these numbers significantly.

Traditionally, we have improved survivability by advancing the vehicle's trustworthiness. Through technology, such as seat belts and air bags, occupants are more likely to survive a crash than they were 20 or 30 years ago. Today we have exciting prospects for advancing safety through new crash avoidance technology suites that could prevent a crash from occurring in the first place. Auto manufacturers are equipping vehicles with lasers, cameras, and various sensors that enable features unimaginable just a few years ago. And NHTSA has been evaluating these technologies.

We have greatly accelerated our efforts to initiate and complete research on the connected vehicles program. V2V or vehicle-to-vehicle communications, are designed to give drivers situational awareness and improve safe decision making on the road.

The V2V program depends on digital short-range communications, or DSRC, technology operating on the FCC license spectrum. Located in the 5.9 gigahertz band, this spectrum is uniquely capable of supporting a number of safety applications that require nearly instantaneous information relay. Since this spectrum was allocated, the Department has conducted significant research developing the concept, supporting consensus standards, and working with the manufacturers on V2V technology development.

Last August, the Secretary launched the Connected Vehicle Safety Pilot Program in Ann Arbor, Michigan. This safety pilot enlists approximately 3,000 specially equipped vehicles operating in day-to-day driving, enabling us to collect real world data that cannot be duplicated in a lab. It represents the largest test ever of connected vehicles in a real-world environment. In this project, we will collect data that we need to make the decision on how to proceed.

As the Transportation Research Board noted, "Electronics systems have become critical to the functioning of the modern automobile." NHTSA recognizes the cybersecurity challenge and have established the Electronic Systems Safety Research Division to focus on these efforts. This division will oversee research focused on evaluating the safety of electronic control systems in five key areas: functional safety design; fail-safe strategies; software reliability; diagnostic notification strategies; and, finally, human factors considerations. We will examine and apply lessons learned from other industries, such as the aviation and medical industries, where loss of life is the primary concern in electronic system failures.

Recently, traditional and non-traditional auto companies have unveiled research projects to develop self-driving cars. Unsurprisingly, people find this intriguing. Automated driving is an exciting frontier for the industry, and we have identified three key areas for preliminary research: human factors research in human vehicle interface, initial system performance requirements, and the electronic control of the system. Our research will inform the agency for policy decisions and assist in developing an overall set of requirements and standards for automated vehicles.

The promise of advanced vehicles is very exciting. While there certainly are risks with any emerging technology, I firmly believe that when these risks are properly identified, understood, and mitigated, it will help minimize those particular risks and reap potential benefits. There are lots of exciting innovations coming, and NHTSA is working very hard, as it has done in the past and will continue to do in the future, to ensure that all of the vehicles on the Nation's roadways are safe and reliable.

Thank you again for this opportunity to testify, and I am happy to take questions at this time.

[The prepared statement of Mr. Strickland follows:]

PREPARED STATEMENT OF HON. DAVID L. STRICKLAND, ADMINISTRATOR, NATIONAL HIGHWAY TRAFFIC SAFETY ADMINISTRATION

Chairman Rockefeller, Ranking Member Thune, and members of the Committee, I appreciate this opportunity to testify before you on what, in my slightly biased opinion, is an extremely exciting subject—the future of the automobile.

The future of the automobile is extremely bright. Increasingly, a car's capabilities are determined more by its electronics than by its mechanics. This is bringing

countless innovations that improve driver comfort, provide useful information and entertainment, and, most importantly, advance safety.

As I have stated many times in prior testimony before Congress, safety is the National Highway Traffic Safety Administration's (NHTSA) top priority. Our programs are all designed to reduce crashes resulting in deaths and injuries. According to early estimates, there were over 34,000 fatalities on America's roadways in 2012. This represents an increase of about 5.3 percent as compared to the 32,367 fatalities that occurred in 2011. If these projections are realized, 2012 will be the first year with a year-to-year increase in fatalities since 2005. In addition to the devastation that these crashes cause to families, the economic costs to society reach into the hundreds of billions of dollars. The advanced safety technologies we are discussing today can help reduce these numbers significantly.

Crashworthiness to Crash Avoidance. We have done a lot to improve vehicle occupant survivability, primarily by advancing the vehicle's crashworthiness. Through technologies such as seat belts and air bags, occupants are more likely to survive a crash than they were 20 or 30 years ago. The agency will continue working on improvements to crashworthiness exemplified by recent final rules on roof strength and preventing occupants from being ejected in crashes. Our current research efforts are aimed at developing improvements to our child safety standards; a new frontal crash test for adults, the elderly, and pedestrians; advancing batteries and other alternative fuel research; and improving our understanding of crash injury and impact mechanisms through advanced biomechanics to develop future crash test dummies and models.

At the same time, there are exciting prospects for improving roadway safety through new crash avoidance technologies. Recognizing the promise these technologies hold, the agency has been aggressively pursuing many of the emerging technologies that are now deployed on new vehicles. We believe these technologies can mitigate a crash or even prevent it from occurring in the first place. For example, because of the agency's research on electronic stability control (ESC), we issued a rule requiring that technology on all new light vehicles since model year 2011 be equipped with ESC to help drivers maintain control of their vehicle in conditions where they might otherwise lose control. Other technologies such as forward crash warning and lane departure warning, both of which help drivers avoid dangerous crash scenarios, are being recognized in NHTSA's vehicle rating program (the New Car Assessment Program, known as NCAP) to help educate the public about the life saving potential that they hold. We continue to evaluate even more advanced technologies that are becoming available as options in production vehicles today. For example, some of these technologies are able to sense an impending crash and either apply the brakes for the drivers if they fail to do so, or are smart enough to know when the driver is not applying enough braking force and supplement the braking force to avoid or mitigate the collision.

NHTSA believes it has the capabilities—and the responsibility—to estimate the effectiveness of these crash avoidance systems, without waiting for years of crash data, in order to make regulatory decisions sooner and save more lives. Without a doubt, the potential for emerging technologies to transform cars and improve safety is breathtaking.

Auto manufacturers are equipping cars with lasers, cameras, radars, and various sensors that enable features unimaginable a few years ago. NHTSA has been studying and evaluating many of the building block technologies that will enable innovations, and this is just the beginning. The automotive technologies that we see are rapidly evolving, and NHTSA is working to understand the potential benefits as well as identify new challenges that they will bring to drivers.

The Transportation Research Board (TRB) published a report last year titled *The Safety Challenge and Promise of Automotive Electronics: Insights from Unintended Acceleration.*[1] In this report, the TRB found that "electronics systems have become critical to the functioning of the modern automobile" and that these systems are interconnected with one another. These interconnected electronics systems are creating opportunities to improve vehicle safety and reliability, but are also creating new and different safety and cybersecurity risks. Furthermore, these electronics systems present new human factors challenges for system design and vehicle-level integration. I am happy to report on our efforts to address these challenges.

Crash Avoidance Research. For the past several years NHTSA has been engaged in research related to many types of crash avoidance systems, including both those that warn the driver to take appropriate action and those that automatically affect a vehicle control function. Much of our early effort was focused on system performance and finding new ways to estimate the effectiveness of these systems. That re-

[1] *www.nap.edu/catalog.php?record__id=13342*

search led the agency to mandate ESC and incorporate systems like forward collision warning and lane departure warning as a recommended technology into the NCAP program. We recommend that consumers look for these particular technologies when a manufacturer demonstrates the technology on its vehicle meets the NCAP performance specification. We are also considering adding additional advanced crash avoidance technology to the current list as a way to (1) inform the consumer and (2) enable the market to pull these emerging technologies into the mainstream. Our most recent analysis indicates that consumers do find the information helpful and manufacturers are increasing the availability of these technologies on new vehicles. We recently published a notice seeking public input on what new technologies should be included in the program and we plan to make a decision on the next advanced technology in FY 2013. Using a more naturalistic setting, our research is now evaluating how our earlier estimates for the benefits of the collision warning systems compare with the learning and improvements that manufacturers have made over the years to these systems. We also hope to learn how drivers are using these systems in their everyday driving.

NHTSA is also evaluating the newest technologies that incorporate active braking in addition to warning drivers to avoid crashes. In particular, NHTSA is focusing its efforts on dynamic braking and crash-imminent braking systems. Such technologies employ radar, camera, lidar or the fusion of these technologies to detect and track vehicles or objects in the forward path and activate the brakes if the driver fails to do so or supplement the driver's braking to avoid or mitigate collisions. We are also evaluating whether enhancements to these systems could be robust enough to detect and avoid pedestrian impacts. NHTSA is currently evaluating system performance in a variety of crash scenarios and under controlled test conditions to develop new ways in estimating the real world benefits these advanced systems could provide. We sought public comments on our initial findings in 2011 and have now conducted additional analyses and research in response to those comments. We will complete our work to inform an agency decision later this year.

Vehicle-to-Vehicle Communications. NHTSA, along with the Research and Innovative Technology Administration (RITA), and the Federal Highway Administration, have greatly accelerated our efforts to initiate and complete research on vehicle-to-vehicle (V2V) and vehicle-to-infrastructure (V2I) platforms designed to increase driver situational awareness and reduce and mitigate crashes. We believe V2V technology will complement and ultimately merge with the advanced braking systems and other crash avoidance technologies that we are currently evaluating to shape the future of motor vehicle safety. V2V will give drivers information needed to make safe decisions on the road that cameras and radars just cannot provide. This added capability not only offers the potential to enhance effectiveness of current production crash avoidance systems, but also enables more complex crash scenarios, such as those occurring at intersections, to be addressed. We currently estimate V2V could potentially address about 80 percent of crashes involving non-impaired drivers once the entire vehicle fleet is equipped with V2V technology. This technology also holds great promise for improving mobility and benefitting the environment by connecting vehicles not just with each other, but also with road infrastructure.

The V2V program has been developed around Digital Short-Range Communications (DSRC) technology that operates on Federal Communications Commission licensed spectrum. Located in the 5.9 GHz band, this spectrum is uniquely capable of supporting a number of safety applications that require nearly instantaneous information relay. Since this spectrum was first allocated, the Department has conducted significant research developing the concept, supporting consensus standards both in the U.S. and with other Nations, and working with the auto manufacturers on coordinated V2V technology development.

For passenger vehicles, we have established a collaborative research effort with a consortium of automobile manufacturers to facilitate the development and are exploring possible deployment of models for V2V communication safety systems. This project is developing several safety applications, addressing interoperability issues, and evaluating safety benefits. We started by holding driver acceptance clinics across the country between August 2011 and January 2012. The evaluation included more than 700 drivers who experienced crash warnings while driving vehicles. The feedback from drivers was overwhelmingly positive, with over 90 percent expressing a desire for such a system in their personal vehicles.

Last August, Secretary LaHood launched the Connected Vehicle Safety Pilot Model Deployment in Ann Arbor, MI. The Model Deployment encompasses various types of vehicles that include a mix of integrated, retrofitted, and aftermarket vehicle safety systems. This program is demonstrating V2V and V2I safety applications, interoperability, and scalability in a data rich environment and provides real-world field data that can be used to develop a better understanding of the operational pol-

icy issues associated with V2V and V2I deployment. The safety pilot program enlists approximately 3,000 specially equipped vehicles to operate in day-to-day driving and provides an opportunity to collect the first-of-its-kind real world data that cannot be duplicated in a laboratory setting. It represents the largest test ever of connected vehicles in a real-world environment. The data are collected on a routine schedule and our researchers are already digging into it. Given the potential of this transformative technology, we have accelerated our efforts. NHTSA will use the results from the Safety Pilot and other studies to decide this year whether to further advance the technology through regulatory action, additional research, or a combination of both. We expect to issue decisions on light duty vehicles this year, followed by a decision on heavy-duty vehicles in 2014.

Vehicle Cybersecurity. As the TRB noted, "electronics systems have become critical to the functioning of the modern automobile." Over the past several decades, the vehicle has evolved from primarily relying on mechanical systems to one with an increasing reliance on computing power and electronics. And with this evolution comes increased challenges, primarily in the areas of system reliability and cybersecurity—the latter growing more critical as vehicles are increasingly more connected to a wide variety of products. Whether the entry point into the vehicle is the Internet, aftermarket devices, USB ports, or mobile phones, these new portals bring new challenges.

NHTSA recognizes this challenge and the growing potential for remotely compromising vehicle security through software and the increased onboard communications services. NHTSA has generally regulated through performance standards developed for specific vehicle systems or sub-systems to address a specific type of safety risk (*e.g.,* frontal collision). However, with electronic systems assuming safety critical roles in nearly all vehicle controls, we are facing the need to develop general requirements for electronic control systems to ensure their reliability and security.

To address this new frontier, NHTSA established within the Office of Vehicle Safety Research the Electronics Systems Safety Research Division that will focus on these efforts. To support the new division, we have requested $2 million in our Fiscal Year 2014 budget proposal for vehicle electronics and emerging technologies research. This division provides NHTSA with a focal point that combines vehicle electronics and automotive engineering to address electronics and software technologies and their implications to vehicle safety. The funding would begin initial research focused on evaluating the safety of electronic control systems in five key areas—(1) functional safety design; (2) fail-safe strategies; (3) software reliability; (4) diagnostic and notification strategies; and (5) human factors considerations. Additionally, we will need to quantify and assess risk for both single vehicle and connected vehicle systems. We will examine and apply appropriate lessons learned from other industries, such as aviation and medical industries, where loss of life is the overriding concern in electronic system failures. We will identify and evaluate potential solutions and countermeasures and consider the need for additional standards or regulations. This will involve collaborating with a variety of stakeholders including the National Institute of Standards and Technology, the White House Office of Science and Technology Policy, the Department of Homeland Security, the Department of Defense, and many private industries.

The division is also focusing on issues related to cybersecurity. Because we recognize their importance in developing safety-critical systems, NHTSA will build off relevant voluntary industry standards and evaluate what manufacturers are already doing. We have initiated cybersecurity research, with the goal of developing a preliminary baseline set of threats and how those threats could be addressed in the vehicle environment. This work will complement and support the agency research to develop performance requirements for automated vehicles.

For the V2V program, our research is evaluating a layered approach to cybersecurity. Such an approach, if deployed, would provide defense-in-depth, managing threats to ensure that the driver cannot lose control and that the overall system cannot be corrupted to send faulty data. In partnership with the auto companies and other stakeholders we have developed a conceptual framework for V2V security. We are also developing countermeasures to prevent these security credentials from being stolen or duplicated. Additionally, we are developing protocols to support a V2V security system that is designed to share data about nefarious behavior and take appropriate action.

Automated Vehicles. Recently, traditional and non-traditional auto companies have unveiled research projects to develop what some call "autonomous" (self-driving) vehicles that can perform certain driving functions automatically. These companies identify safety as one of the compelling factors favoring automation. They envision a system of cameras, radar, lidar, and other sensors integrated with sophisticated algorithms that can monitor the road in an increasingly wide variety of road-

way, weather, and traffic scenarios with greater awareness and more rapidly and reliably make decisions than the average driver. Not surprisingly, this vision has captured the Nation's attention. What was once previously thought of as science fiction and decades away from reality may now appear to be just around the corner, particularly as some of these companies are touting that they will have a commercially available vehicle in the next five years.

Vehicle manufacturers have already begun to offer and in some cases, such as Electronic Stability Control, NHTSA has already regulated what we call single function automated systems. Manufacturers continue to develop these systems and are now combining functionalities to achieve higher levels of automation. Some vehicle manufacturers indicate that consumers will see some of these more advanced combined systems in the U.S. in the next few years but full self-driving is several years away. NHTSA has been actively involved in researching the near term technologies because we already believe many of them hold great safety promise. For example, NHTSA is engaged in research to evaluate the effectiveness of currently available automated braking systems in avoiding or mitigating crashes. As part of this research, the agency is developing test procedures to evaluate the technologies and methods to assess their safety benefits, as previously mentioned.

NHTSA conceives of these many and varied innovations as three distinct streams of technological change and development that are occurring simultaneously—(1) in-vehicle crash avoidance systems that provide warnings and/or limited automated control of safety functions; (2) V2V communications that activate various crash avoidance applications; and (3) self-driving vehicles.

The confluence of these three streams of innovation has created a fair amount of confusion in making distinctions between different concepts and in finding commonly understood category descriptions. NHTSA finds that it is helpful to think of these emerging technologies as part of a continuum of vehicle control automation. The continuum, discussed below, runs from vehicles with no active control systems all the way to full automation and self-driving. While NHTSA is conducting research along the entire automation continuum, our emphasis initially is on determining whether those crash avoidance and mitigation technologies that are currently available (or soon to be available) are not only safe, but effective. Because these same technologies are the building blocks that may one day lead to a driverless vehicle, we have also begun research focused on safety principles that may apply to even higher levels of automation, such as driver behavior in the context of highly automated vehicle safety systems.

NHTSA has proposed definitions for five levels of automation to allow for clarity in discussing this topic with manufacturers, policymakers, and other stakeholders. The definitions cover the complete range of vehicle automation, ranging from vehicles that do not have any of their control systems automated (level 0) through fully automated vehicles (level 4).

Level 0—No Automation. At the initial Level 0, the driver is in complete control of the primary vehicle controls (steering, brake, and throttle) at all times, and is solely responsible for monitoring the roadway and for safe operation of all vehicle controls. Vehicles that have certain driver support or convenience systems, but do not have control authority over steering, braking, or throttle, would still be considered Level 0 vehicles. Examples include systems that provide only warnings (*e.g.,* forward collision warning, lane departure warning, blind spot monitoring) as well as systems providing automated secondary controls such as wipers, headlights, turn signals, hazard lights, etc. Although a vehicle with V2V warning technology alone would be considered Level 0, that technology could significantly augment, and could be necessary to fully implement, many of the technologies described below. Furthermore, it would be capable of providing warnings in several scenarios where sensors and cameras cannot (*e.g.,* vehicles approaching each other at intersections).

Level 1—Function Specific Automation. Level 1 automation involves one specific control function that is automated (note: a Level 1 vehicle may feature multiple automated functions, but they operate independently from each other). The driver still maintains overall control, and is solely responsible for safe operation, but can choose to cede limited authority over a primary control. Examples of Level 1 automation include:

- adaptive cruise control, where the driver sets a specific speed and does not have to continue pressing the accelerator;
- electronic stability control, where the vehicle automatically reduces power to the wheels and/or applies brakes when cornering too aggressively; or
- dynamic brake assist, where the vehicle automatically provides additional braking power if it senses that the driver's braking input is insufficient to avoid a collision.

The vehicle may have multiple capabilities combining individual driver support and crash avoidance technologies, but it does not replace driver vigilance and does not assume driving responsibility from the driver. The vehicle's automated system may assist or augment the driver in operating one of the primary controls—either steering or braking/throttle controls (but not both). As a result, there is no combination of vehicle control systems working in unison that enables the driver to be disengaged from physically operating the vehicle by taking hands off the steering wheel *and* feet off the pedals at the same time.

Level 2—Combined Function Automation. Level 2 automation involves at least two primary control functions designed to work together to relieve the driver of control of those functions. Level 2 automated vehicles share authority allowing the driver to cede active primary control in certain limited driving situations. Combining adaptive cruise control with lane keeping assistance would be an example of Level 2 automation.[2] The driver is still responsible for monitoring the roadway and is expected to be available for control at all times and on short notice. The system can relinquish control with no advance warning and the driver must be ready to take control of the vehicle safely. The major distinction between Level 1 and Level 2 is that, at level 2, in the specific operating conditions for which the system is designed, the driver can disengage from physically operating the vehicle by taking hands off the steering wheel *and* feet off the pedals at the same time.

Level 3—Limited Self-Driving Automation. Level 3 automation enables the driver to cede full control of all steering, brake, and throttle functions to the vehicle. The driver is expected to be available for occasional control, but with a comfortable transition time that will enable the driver to regain situational awareness. The vehicle is designed to ensure safe operation during the automated driving mode, observing all rules of the road. An example would be an automated or self-driving car that can determine when the system is no longer able to support automation, such entering a construction area. At this point, the vehicle signals the driver to reengage the driving task. The major distinction between Level 2 and Level 3 is that, at Level 3, the vehicle is designed so that the driver is not expected to constantly monitor the roadway while driving and provides sufficient time for the driver to reengage in driving.

Level 4—Full Self-Driving Automation. The vehicle is designed to perform all safety-critical driving functions and monitor roadway conditions for an entire trip. Such a design anticipates that the driver will provide destination or navigation input, but is not expected to be available for control at any point during the drive. This includes both occupied and unoccupied vehicles. By design, safe operation rests solely on the automated vehicle system.

By ensuring that our research plan includes the entire automation continuum, the agency strives to remain knowledgeable about the full range of potential benefits and risks of increasing vehicle automation. The agency's work on automated vehicles is designed to——

- address safety questions about driver engagement and re-engagement across levels of automation;
- evaluate concepts of operation and development of system requirements; and
- provide guidelines for automated sensing and control.

As we continue our work on Level 1 automation and our efforts to calculate the safety benefits that those single-function systems may offer in the near term, we have begun new research on Levels 2–4. NHTSA is working cooperatively with other DOT agencies on this research, given its relevance to the intermodal Intelligent Transportation Systems program. We are also engaged in a broader policy development process across the Executive Branch. For our part, we have identified three key areas for preliminary research—(1) human factors and the human-vehicle interface; (2) initial system performance requirements; and (3) electronic control system safety. NHTSA's research will inform policy decisions, assist in developing an overall set of requirements and standards for automated vehicles, identify any additional areas that require examination, and build a comprehensive knowledge base for the agency as automated system technologies progress.

Driver Distraction. In 2011, 3,331 people were killed in crashes involving a distracted driver, compared to 3,267 in 2010. An additional 387,000 people were injured in motor vehicle crashes involving a distracted driver, compared to 416,000

[2] Adaptive cruise control utilizes sensors (often radar) to automatically adjust speed to maintain a safe distance from vehicles ahead. Lane keeping systems will automatically take steps (through steering adjustments) to keep the vehicle in its lane if sensors detect that the vehicle will depart from the lane.

injured in 2010. Driver distraction is a very real problem on our roadways given the growing use of cell phones and other such handheld devices in the vehicle. We are also concerned whether new safety systems, with a variety of audio, visual, or haptic warnings, are appropriately designed and sufficiently effective. Additionally, we are concerned about non-safety applications causing further distractions.

Connectivity and Portable Devices. Drivers perform secondary tasks (communications, entertainment, informational, and navigation tasks not required to drive) using in-vehicle electronic devices by interacting with them through their user interfaces. The user interfaces of these devices can be designed to accommodate interactions that are visual-manual, auditory-vocal, or a combination of the two. Some devices may allow a driver to perform a task through manual manipulation with visual feedback, through voice command with auditory feedback, or a combination of the two. Given the potential for distraction, NHTSA focused new research in these two broad areas.

Last month, we issued voluntary guidelines for electronic devices installed in vehicles (at the time they are manufactured) whose use requires drivers to take their hands off the wheel or eyes of the road to use them.[3] Our goal in doing so is to encourage the design of in-vehicle device interfaces that minimize driver distraction associated with performing a non-driving task. The guidelines specify criteria and a test method for assessing whether a secondary task performed using an in-vehicle device may be acceptable for performance while driving. The guidelines also seek to identify secondary tasks that interfere too much with a driver's ability to safely control the vehicle and to categorize those tasks as ones that are not acceptable for performance by the driver while driving.

NHTSA will begin discussions very soon with the various stakeholder groups and organizations affiliated with portable and aftermarket devices. NHTSA values the input from the full range of stakeholders for portable devices, including device makers, operating system providers, cellular service providers, application developers, and industry organizations that represent these different groups. We are eager to listen to their input on how best to apply the visual-manual guidelines to this important device category.

In-vehicle and portable devices that use auditory-vocal interactions are on the rise and therefore must also be studied. These involve the driver controlling the device functions through voice commands and receiving auditory feedback from the device. NHTSA is conducting work in this new and complicated area to determine if guidelines are warranted. Because a single device's driver interface could accommodate both visual-manual and auditory vocal interactions, NHTSA is evaluating appropriate auditory-vocal test procedures and acceptance thresholds that could be added to the visual-manual and portable distraction guidelines.

Driver Vehicle Interfaces for Warning Systems and Automated Vehicles. Recognizing the risks of driver distraction, vehicle warning systems introduce a new set of challenges to the driver. Many current crash avoidance systems provide a warning to the driver, expecting the driver to take appropriate action (engage the brake or steer) to avoid a crash. In order to determine if regulations or standardization is needed, there are several issues we need to understand better, such as: will the driver understand the warning systems when they activate given the variety in the vehicle fleet, will the driver become startled if the vehicle intervenes to avoid a crash, or is there a better way to warn the driver?

We are conducting extensive human factors research with the goal of developing requirements for the driver-vehicle interface for automated vehicles. The objective is to ensure that drivers can safely and seamlessly transition between automated and non-automated vehicle operation, and that any additional information relevant to safe operation is effectively communicated. The research will primarily focus on Level 2 and 3 systems. As new automated driving concepts emerge, we will evaluate the need for driver training in automated systems. Additionally, NHTSA will be developing test and evaluation tools (simulators, test vehicles, etc.) to evaluate driver and system performance for various automated vehicle concepts.

As a first step toward completing research on these issues, the agency is evaluating emerging Level 2 and Level 3 system concepts to answer fundamental human factors questions. The evaluation will examine how drivers react and perform in these types of automated vehicles. In addition, we will consider driver vehicle interface concepts that may be needed to ensure that drivers safely transition between automated driving and manual operation of the vehicle. Ultimately, we want to improve motor vehicle safety by defining the requirements for automation in normal driving that are (1) operationally intuitive for drivers under diverse driving condi-

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[3] *www.nhtsa.gov/About+NHTSA/Press+Releases/U.S.+DOT+Releases+Guidelines+to+Minimize+In-Vehicle+Distractions*

tions; (2) compatible with driver abilities and expectations; (3) supportive of improving safety by reducing driver error; (4) operational only to the extent granted by the driver and always deferent to the driver; and (5) secure from malicious external control and tampering. Through this research, we hope to develop recommendations for specific requirements needed for the driver-vehicle interface to allow safe operation and transition between automated and non-automated vehicle operation.

As you can see, the promise of advanced vehicles that can avoid crashes is extremely bright. While there are certainly risks with any emerging technology, I firmly believe that, when this risk is properly identified, understood, and mitigated, we can minimize it and fully reap the potential benefits. There are a lot of exciting innovations coming, and NHTSA is working hard, as it has done in the past and will continue to do in the future, to ensure that all vehicles on the Nation's roadways are safe and reliable. I thank you again for this opportunity to testify, and I am happy to take questions.

The CHAIRMAN. Thank you, Administrator Strickland, very much.

Three years ago, you and Secretary LaHood sat at this same—that same table for a hearing examining some unintended acceleration of Toyota vehicles and NHTSA's investigation into those incidents. At that time, I was concerned about NHTSA's capacity to investigate electronic issues.

Two years later, the National Academies of Science released studies demonstrating nearly the same concerns. And today we are discussing the explosive growth of electronics in vehicle.

So my first question to you would be how well are you prepared for this? I mean, your testimony was sort of general, umbrella-like, and did not dig deep, which is what questions are for. But I need to know how good—how you realistically assess yourself and your staff in terms of the numbers of people assigned, assuming that the cars are going to do this, keep on adding things to make it more attractive, so that safety will continue to be the main factor.

Mr. STRICKLAND. Mr. Chairman, the Secretary and I are very satisfied with the staff that we have on hand to deal with this issue. Our budget request has given us adequate resources, and we have the adequate talent on hand right now. As I mentioned in my testimony, we have a new electronics office within our Vehicle Safety Research team, which is specifically focused on dealing with all issues regarding electronics. We have about 12 full-time employees with electrical engineering backgrounds and this type of software background to deal with these issues, and we are adding more every single day.

So in terms of our game plan, I will definitely submit a more detailed answer for the record about the game plan for the Electronics Research Office, but we really do have a very solid plan on how we are going to be dealing with all of these issues, including a process standard for looking at electronics reliability, looking at vehicles fail—safe when the electronics do fail; and those particular countermeasures.

In addition, as we did during the Toyota investigation, we will always leverage the expertise of our sister agencies across government, such as NASA or the Federal Aviation Administration, to assist us in this task.

The CHAIRMAN. Well, I am well over my time, so I will yield to my superiors. But I am not satisfied with the answer.

Senator THUNE. Thank you, Mr. Chairman. I just want to follow up, if I might, and ask you, Mr. Strickland, with all these cutting-edge automotive technologies, I am curious to hear what changes,

if any, you think may be necessary to the Federal motor vehicle safety standards to ensure that we bring these technologies to market safely.

Mr. STRICKLAND. Well, at this point, we are going to be doing a full policy analysis on looking at the current Federal motor vehicle safety standards. You know, there are some things clearly from a policy aspect that you have to consider, such as those standards that deal with the driving position which presumed that there is a driver that is constantly engaged in managing the vehicle. So those particular standards are going to have to be addressed, especially considering that you may have some driving scenarios with technology where the driver may be not necessarily fully within the loop for a period of time.

In addition to that, Ranking Member, we are looking at preparing ourselves and working with the industry, looking at the research and development so that when we approach commercialization we will be ready, if needed, to have additional Federal motor vehicle safety standards on-board to make sure that we have the certainty that we are not introducing a technology that may pose an unreasonable risk to safety. But that is very preliminary. We are clearly in the research and policy phase at this point in making those evaluations.

Senator THUNE. And I think the vehicle safety standards also help shape the automotive design process and can create incentives and disincentives for firms to invest in new technologies. This is especially true for those technologies that have obvious safety benefits, but which may not conform to the existing standards.

In your opinion, are the current standards flexible enough to foster new innovations, while at the same allowing NHTSA to meet its vehicle safety mandate?

Mr. STRICKLAND. At this point, we believe that we have the flexibility. But as I said, Ranking Member, we are looking at this with a very sharp pencil, if you will.

The one thing that you have to think about is that some of the Federal motor vehicle safety standards were written over 30 years ago. But we do believe that there is flexibility in terms of dealing with how the particular safety systems that those standards actually involve.

And what you are thinking of more as an application of these particular technologies, brake application, and you are thinking about directional control, human machine interface. All of these things are already captured by the standards right now. And the thing we want to make sure that we do is that we have the correct pathway to encourage that innovation in a safe way. Whether you are thinking about the testing or thinking about the development, the last thing you want to do is to chill innovation, but you should not have to compromise for safety.

Senator THUNE. OK. Mr. Chairman, I will be happy to yield to some of our other colleagues and then come back for a question later.

The CHAIRMAN. All right then. Senator Nelson?

STATEMENT OF HON. BILL NELSON,
U.S. SENATOR FROM FLORIDA

Senator NELSON. Thank you, Mr. Chairman, and again, another alum of the Commerce Committee makes good.

Mr. STRICKLAND. Thank you, sir. Great seeing you again.

Senator NELSON. So, welcome. The Chairman in his opening comments made reference to the kid in Indonesia suddenly interfering. Let us take that a step further: cybersecurity implications. Tell us about that.

Mr. STRICKLAND. Well, there are several. And the Chairman made a very excellent point in that looking at the advances in the connectivity of vehicles and the opportunity for mischief that can go well beyond pure mission. That can actually mean an impact on life, possibly, if something that severe happens.

This is what we do know. At this point right now there has never been an unauthorized access of a vehicle that is currently on the road today. From our research at this point, a person would need physical access to a vehicle in order to get control of particular vehicle functions. However, recognizing the future, there are going to be opportunities where there will be chances for software linkages and Internet downloads in vehicles. And for that, we have a very rigorous program looking at the cybersecurity issues in terms of reliability, looking at the proper standards of encryption, and how we deal with certificate packages, and all of those other issues that we do not want to be behind on.

We are relying upon, frankly, not only the work that we have been doing with the auto makers, but also, in other parts of the industry, FAA, et cetera, to be able to look through it to help us gain a pathway forward as we think about these cybersecurity issues.

Senator NELSON. Does it involve an allocation of part of the spectrum that if you denied that spectrum, that you could help yourself from a cybersecurity attack?

Mr. STRICKLAND. Well, clearly one of the issues that are involved within the vehicle-to-vehicle program is the security protocol and that is clearly part of the spectrum. We are working very hard with the Manufacturers Consortium on these issues, and moving forward.

The question in regard to how much spectrum will be needed to be able to help deal with the cybersecurity issues, I would have to get back to you in more detail on that. But it is clearly part of our analysis going toward the agency decision. In any case, with the individual manufacturers, their decisions on how to control vehicle mechanisms off board using software is clearly the responsibility of the manufacturers, and I am sure that Mr. Bainwol can address. But for us, we have to lay down a process to make sure that there is a proper encryption standard for every vehicle to be able to fight off such an attack.

Senator NELSON. Have you ever requested assistance from NASA?

Mr. STRICKLAND. Absolutely, sir. Frankly, one of our best collaborative relationships, since I have been in office for sure, is how the NASA team helped us in the Toyota investigation. They have really——

Senator NELSON. Tell us about it.

Mr. STRICKLAND. Well, certainly. Well, we recognized that we needed to have an outside verifier of the work that NHTSA had done preliminarily on unintended acceleration and electronics control. We felt that NASA having, you know, the ultimate expertise in dealing with software issues, spin testing and all of the other things that they do, and failure mode analysis, we brought them in.

NASA worked shoulder to shoulder with the NHTSA engineers and with Toyota. The Toyota Camry they looked at, I believe, had over 300,000 lines of code, and their expertise verified what NHTSA had contended all along, that there were no issues regarding software electronics reliability in the unintended accelerations. It was down to the two pedal issues identified by NHTSA. But that work could not have been done without the assistance of NASA.

Senator NELSON. Final question: are you working on a technology that will not allow someone to text while driving?

Mr. STRICKLAND. Sir, that is, frankly, one of my most focused areas of emphasis. And the one thing that we are interested in asking the Committee's support and help on is the opportunity to pull together stakeholders across the industries involved in this space, not only the automakers and us, but also the handset suppliers and the wireless communications companies. We believe that while we are very bullish on the program on distracted driving, we think that a technical solution that could identify the harm, that could differentiate a driver's phone from a passenger's phone, interlock the driver's phone (unless it is connected to the vehicle), is the long-range technology shot to make sure that we end distracted driving. And I am very focused on that.

Our hope is that we can pull these stakeholders together in a public-private way for us to work on this technology in a voluntary and collaborative way, and I think it is doable. But we would love to have the support of this committee in putting that type of stakeholder group together to work on this.

Senator NELSON. Thank you.

The CHAIRMAN. Thank you, Senator Nelson.

Senator Johnson?

STATEMENT OF HON. RON JOHNSON,
U.S. SENATOR FROM WISCONSIN

Senator JOHNSON. Thank you, Mr. Chairman. Mr. Strickland, I am new to the Committee, new to this issue, so I will be asking some pretty basic questions.

You mentioned the Highway Safety Act, 1970, so it is actually 40 years old? I was not here then.

Mr. STRICKLAND. There is the original Act from 1966, and there is the update in 1970, which created NHTSA. We were changed from the National Transportation Safety Bureau in 1966 to NHTSA in 1970. But, yes.

Senator JOHNSON. OK. Can you tell me which of the safety improvements that we all enjoy today—air bags—— how many of those are market driven, voluntary, versus what are imposed by the Highway Safety Act?

Mr. STRICKLAND. Well, basically the Highway Safety Act created a base set of standards, and a number of those technologies and in-

novations began within the automotive fleet as innovations by the manufacturers. And as we learned over time following data and effectiveness, they eventually evolved into regulatory standards.

In terms of the ones that were mentioned specifically by the Safety Act, there are actually initial frontal crash standards and those types of things which were initially laid out. We are talking about things such as air bags, and seat belts. Seat belts were part of the original Act, I believe, in 1966, but clearly that has evolved over time. For example, we actually had a regulation on seatbelt interlocks, which was subsequently changed.

The original Act built a foundation and a process for the agency to look at technologies which show promise in reducing traffic injuries and saving lives. That foundation allowed us to pull these additional innovations over the years into the regulatory regime of NHTSA.

Senator JOHNSON. So what happens then? So it maybe is driven by the—the innovations are driven by the auto companies? You like what you see, and then over time that becomes a standard that is imposed? I mean——

Mr. STRICKLAND. Processwise, yes, sir. We really are a data-driven, science-based agency, and we set performance standards for vehicles. We do not ever pick design standards because you may stifle innovation, and you may foreclose an opportunity for safety in the future.

A classic example I would probably say in terms of process is the mandate of the electronic stability control system, which was an innovation that was put into vehicles starting in 1990. As we got more data over time on the effectiveness of these particular technologies, we were able to prove the cost and the benefits for us to move to a regulation, ultimately mandating them to be in every vehicle starting in 2012.

That particular regulation has saved thousands of lives since it has come into effect. And it is a classic example of how you build your decisions upon data and science in order to make the ultimate regulatory decision that can show the cost and the benefits of the action.

Senator JOHNSON. Have you ever just done a study in terms of what has been transformed over time from voluntary and mandatory and what the cost of those mandatory safety standards are per vehicle?

Mr. STRICKLAND. Oh, in terms of every rulemaking we have to do, we are obligated to show, the cost and the benefits. And we can definitely do a comparative analysis for you, sir, that tracks the movement of those technologies that were voluntarily included in vehicle packages that ultimately became regulations.

But the flip side of making something a regulation and standardizing it across the fleet is that you actually get learning. You decrease costs. You get economies of scale, which actually makes those technologies much more affordable, and ultimately you are democratizing safety. And that is the benefit of being able to build rules on the basis of sound data, sound science, and effectiveness.

Senator JOHNSON. So is your agency undertaking a study to say today or whenever you might have conducted the study, this is what the cost of the mandate and safety requirements are?

Mr. STRICKLAND. Well, what we do in our notice of proposed rulemaking is conduct an initial analysis of costs and benefits.

Senator JOHNSON. That is a particular safety thing.

Mr. STRICKLAND. Right.

Senator JOHNSON. And, again, I am just asking just in general, just, you know, for a standard consumer. Are we talking—has it added $5,000 to a standard car, all the mandated safety items?

Mr. STRICKLAND. Well, in terms of looking at the overall cost, I think every decision that we make may add a particular cost to the vehicle. But there are also ways to determine the tipping point of those particular benefits and whether or not you will be pricing out a particular segment of the buying public from individual mobility.

We can definitely talk more in general about the history of our rules and how they have done this. But in the decisions made by the agency over the years, we have kept individual mobility affordable, while also raising the margin of safety to the point where we have actually decreased loss of life by 25 percent over the past decade or so.

Senator JOHNSON. An inquiring mind like mine would just kind of want to know what that total cost per vehicle would be. If you could—if you have something like that, I would be interested in hearing it.

Mr. STRICKLAND. We will definitely get back to you, sir.

Senator JOHNSON. Yes. One obviously government-imposed standard is mileage standards, which at the same time then reduces vehicle weight. Can you speak a little bit in terms of the offset of that and really what, you know, what is the—what is the criteria in terms of weight? I mean, I have heard things like if in a crash, just a 10 percent reduction or differential in terms of vehicle weight increases the chance of fatality by 10 times. I mean, is that the basic rule of thumb? Is that accurate?

Mr. STRICKLAND. Well, Senator Johnson, I have a group of engineers that are way smarter than I on the particular physics issues. Actually our new deputy administrator had that as one of his areas of expertise in his old job, so I will let those guys give you a more detailed answer off the record.

I will say that in finalizing the rules for 2017 to 2025 in partnership with the EPA, we wanted to have the most aggressive standard possible while ensuring that the benefits outweighed the costs, and making sure that there was no impact on safety. The work that we did for that rule, and the proceeding rule (2012 to 2016) accomplished that.

We would be more than happy to talk about the math, size and weight issues, and the impacts of light weighting. We actually had a symposium earlier this week for 2 days talking about mass and size issues as we go toward the mid-term review.

But our first priority is safety, sir. We are not going to compromise safety. And we were very happy to have a safety-neutral set of fuel economy standards. And I know the industry is also very focused on that as well. We will definitely get back to you in more detail off the record on those particular issues.

Senator JOHNSON. OK, thank you.

Mr. STRICKLAND. Thank you, sir.

Senator JOHNSON. Thank you, Mr. Chairman.

The CHAIRMAN. Thank you, Senator.
Senator Pryor?

STATEMENT OF HON. MARK PRYOR,
U.S. SENATOR FROM ARKANSAS

Senator PRYOR. Thank you, Mr. Chairman, and Administrator Strickland, it is always good to be with you.
Mr. STRICKLAND. Great seeing you again, sir.
Senator PRYOR. How are you?
Mr. STRICKLAND. Fine. Sorry that you changed subcommittees on me, and now you are over in communications. You jumped to the other tribe.
[Laughter.]
Senator PRYOR. That is true, I did. Let me follow up on one of Senator Johnson's questions there just in general. What we are talking about today is advanced technology in vehicles. Is that right now being driven by the industry, the auto industry, or is it being driven by your agency?
Mr. STRICKLAND. The industry innovates, and I have to say that while we are very proud of the work that we do at NHTSA, the hard work of the auto makers to improve vehicle safety has driven the universe forward in terms of what the expectation is of a vehicle.
Clearly we set the floor in terms of the Federal motor vehicle safety standards, and manufacturers innovate and go well beyond that. We create another incentive using the new car assessment program, or NCAP, the five-star safety rating, which is a market incentive to go beyond the Federal motor vehicle safety standards.
But it is the auto makers that innovate for things such as crash and braking systems, which we are continuing to study, and those systems are on cars right now—adaptive cruise control, lane departure warning. So it is that innovation that gives us the opportunity to look at effectiveness and hopefully find a path forward for those technologies that show promise that may be put throughout the entire fleet.
Senator PRYOR. Great. So let me follow up on that then. In your opening remarks, you mentioned that once fully implemented, vehicle-to-vehicle technology could potentially address about 80 percent of the crashes involving non-impaired drivers.
So can you give us an estimate of the timeline on which you think this technology will be implemented on a mass scale, you know, not just with the very highest-end cars, you know, mass scale?
Mr. STRICKLAND. Sure. Well, Senator, the agency will be making a decision this year on how we are going to proceed on vehicle-to-vehicle technology based upon the data we receive from the safety pilot and other research that we are doing.
If—and I truly underscore "if"—the agency decides to go forward in a rulemaking posture to mandate V2V, it will take some time for the vehicle fleet to turn over and have that technology in every vehicle. The other part that we are looking at is the provision of aftermarket beacon so that people can actually, you know, put these beacons into their car and receive benefits immediately.

But turning over the fleet takes decades. The average life of a car now is well over 12 to 15 years, so thinking about having the fleet turn over enough times to get that in every vehicle will take some time.

Senator PRYOR. Yes. OK. So let me ask another question a little more specifically about the five gigahertz band. The FCC, as you know, recently has talked about unlicensed use of five gigahertz band, et cetera. Can you tell us how you are working with the FCC to make sure everybody is on the same page here and understands what the future of five gigahertz may be?

Mr. STRICKLAND. Well, the Department provided comments to NTIA, I believe earlier this week, about the work forward in terms of their testing evaluation of compatibility of sharing the spectrum. I will say that the Deputy Secretary in a statement during a roundtable last week voiced, I guess, the questions that we have at the Department of Transportation about that the FCC sort of initiating its notice of proposed rulemaking before the NTIA has had an opportunity to do the technical work.

We felt frankly, that the process—the NTIA process should have informed the FCC process before the FCC went forward. And we made note of that in our comment.

Senator PRYOR. So in other words, you, and I do not want to put words in your mouth, but you may be concerned that some of this new technology in vehicles may have interference issues with, like, Wi-Fi and other things.

Mr. STRICKLAND. The concern that we have is that as we are allocated the use of this particular spectrum, it is incumbent upon any other unlicensed user to not interfere with the Department of Transportation's 5.9 gigahertz. It is a safety function, and as a safety opportunity it could address up to 80 percent of crashes of unimpaired drivers.

The only thing that we are looking for is making sure that the process actually is followed in the correct manner, which is that we actually get the technical work done to determine whether or not there is an interference issue before we go forward to the next step for the FCC to issue a rule, which may possibly preclude the notion of the technology advice.

Senator PRYOR. And does NTIA do the work for you?

Mr. STRICKLAND. They are working on that. That is the process right now.

Senator PRYOR. And do you know how long it will take them to——

Mr. STRICKLAND. I have to get back to you on the record on that. I am not sure about the timeline for NTIA.

Senator PRYOR. Mr. Chairman, thank you. That is all I have.

The CHAIRMAN. Thank you, Senator Pryor. Let us wheel around once again.

Let me just put it bluntly. We are talking about sort of making cars into virtual offices because they are connected to everything, including through the Internet to the entire world. I want you to explain to me, and I do not want you to say I will send you an answer—a written answer on that.

Mr. STRICKLAND. Yes, sir.

The CHAIRMAN. I want you to explain to me as best as you can what is the tipping point when distractions that may have to do with, you know, my music, or somebody's business, or Internet capacity, or all the—you know, being wired up, all the things that happen when you fulfill modern dreams of what a car should be. At a certain point, that begins to work absolutely at an uncertain—in certain terms, against the interest of safety. It is an inevitable fact.

I would like you to give me a sense of where your sense of that tipping point could be, or if you accept the concept. Your job is safety. Your job is not trinkets.

Mr. STRICKLAND. Absolutely right. Sir, it is not a question of a tipping point to me. There is an absolute first value. The first thing that anybody should do behind the wheel of a car is drive. Everything else is ancillary, and not just ancillary, frankly, disposable.

But through the work that we have done at NHTSA, in our human factors research and our other research that has given the zone of safety. What is an amount that could be handled behind the wheel? That informed our in-vehicle guidelines that were released a few weeks ago, which outline the zone of safety. Basically any task within the vehicle that can be completed within 2 seconds for an individual action or up to 12 seconds for back and forth continual actions, is safe. It is the equivalent of tuning a radio in the vehicle, which we have seen over the decades is a safe operation of an additional task in the vehicle.

Additionally, we have taken a very hard look at those additional things that we find could be dangerous, such as a GPS system that does not lock out when the vehicle is underway. You do not want people typing 2121 McGillicuddy Way doing 70 miles an hour down the road. We have suggested that the system be locked out. We do not want social messaging to be happening while the vehicle is underway. That should be locked out. And frankly, it should be locked unless the vehicle is in park, not just when the vehicle is moving at five miles an hour, which the current voluntary standards allow for. We believe that we have found the correct zone of safety for the human machine interface and visual manual distraction, which we know are incredibly dangerous.

So, sir, we are not playing the line. I think that we have drawn a really clear line in the sand about what we think the zones of safety are. And that is so that the automakers can then innovate around that zone of safety. If they can do particular tasks to provide information and services within that zone of safety, that is space for innovation. If they cannot, it should not be in the vehicle. And that is where the line is.

The CHAIRMAN. Well, I am trying to parse your words to see what your answer told me. Do you think that it—first of all, I think it is a fact that increasingly younger people are not buying cars?

Mr. STRICKLAND. That is true.

The CHAIRMAN. And they are using other modes of transportation. And that has some benefits to me in terms of safety for the future because they want to be wired up. They want to be, you know, a moving office, connected to everything.

Explain to me why the concept of a wired up automobile which can do any kind of transaction, and you say it has to be done in

2 seconds. I would actually question that because I remember we were talking a few years ago, if you spend three or 4 seconds and you are on an interstate or highway, you have gone the lengths of two or three football fields. And in West Virginia, if you do that, you have crashed seven times just because of the hilly territory.

So why do you have an accepting attitude, if you do, that we are coming upon a time when cars will have the ability for people to sit in the cars and have it as an office space? It scares the heck out of me.

Mr. STRICKLAND. Well, sir, we are not accepting that a car is an office place while you are rolling. There are some things that are analogous to current tasks which are within the zone of safety, and we are happy to brief you in more detail about our research that shows that you can complete a task safely within 2 seconds. That is solid fact.

We want to lock out anything that resembles a driver trying to input large amounts of text, or even small amounts of text. Anything that is akin to radio, such as audio being read back to you or the ability to be able to enter an address by voice is an opportunity. Those things we think have possibilities, and they are safe.

But you are absolutely right, sir. You have people that are interested in surfing the Internet, typing large amounts of text, anything of that nature, and you are right, it should be out of the vehicle, and we encourage that auto makers interlock and prohibit those particular practices. But we also recognize that there is a large amount of information, and, frankly, driver support that is provided by these systems. And those are good things.

GPS is such a system. That is a good thing when properly used. People being able to receive messages that their car can actually speak back to them is like a radio. That is potentially is a good consumer item that somebody could use within the zone of safety.

But you are absolutely right: 95 percent of what you are seeing in terms of the true social application of people texting, and tweeting, and bouncing stuff back and forth, watching streaming video, and all of those things, is not appropriate for the vehicle, and we strongly would fight against permitting that. But you cannot simply say that an antiseptic environment in the vehicle is also a realistic one. I think if we recognize those things that can be done safely and are very strict about it, we encourage innovation; we encourage the opportunity for good information and service to be provided to the driver in support of the driving task; and we allow the opportunities for things that we do not anticipate to develop. And that is the balance that we are looking for, and we feel very strongly about that.

The CHAIRMAN. OK. Senator Thune?

Senator THUNE. Chairman, I really do not have any more questions. I do want to say that if we did V2V connectivity that we could probably listen to—we could listen to Bach with you.

[Laughter.]

Senator THUNE. I do want to thank you, Mr. Strickland, for something that you helped our office with, the B.A.T. Mobile——

Mr. STRICKLAND. Oh, right.

Senator THUNE. It is a new vehicle technology. It is a breath alcohol testing mobile, and in getting one into the Great Plains re-

gion, that will be very helpful in the mission that we have of improving public safety on our Indian reservations in our State. So, thank you for your help with that.

Mr. STRICKLAND. Well, thank you, Mr. Thune. There is an area that we were very focused on, improving vehicle safety in Native territories and reservations, because unfortunately Native Americans are overrepresented in a lot of very bad crash areas; lower seat belt use; higher drunk driving rates; higher crash rates; and the worst fatality numbers. Anything that we could do to help address those through countermeasures is something that we are very strongly supportive of. We were happy to help in getting you the B.A.T. Mobile.

Senator THUNE. Appreciate that.

Mr. STRICKLAND. Thank you.

Senator THUNE. Thank you. Thank you, Mr. Chairman. No other questions.

The CHAIRMAN. Thank you, Senator. Are there—Senator Johnson? Senator Pryor?

Administrator Strickland, thank you very much.

Mr. STRICKLAND. Thank you, Mr. Chairman, for the opportunity. I always appreciate it.

The CHAIRMAN. Thank you.

The CHAIRMAN. All right. Now our next panel.

Mr. Mitch Bainwol, who is president and CEO of the Alliance of Automobile Manufacturers here in Washington; Mr. Jeffrey Owens, Executive Vice President and Chief Technology Officer, Delphi Automotive, Troy Michigan; Dr. Peter Sweatman, Director of University of Michigan Transportation Research Institute; and Dr. John Lee, Emerson Electric Quality and Productivity professor, University of Wisconsin at Madison, Wisconsin.

Why do we not start with you, sir?

STATEMENT OF MITCH BAINWOL, PRESIDENT AND CEO, ALLIANCE OF AUTOMOBILE MANUFACTURERS

Mr. BAINWOL. Mr. Chairman, thank you very much for the opportunity to be here today to testify at this extraordinary time for mobility. A decade ago, the CDC celebrated the reduction of traffic deaths as one of the 10 great public health achievements of the 20th century. Since then, deaths per mile traveled are down another 25 percent.

These gains result from many factors, including an increased use of seat belts and decreased incidents of drunk driving, as well as crash worthiness technologies mitigating the impact of accidents. Going forward, progress will come from technologies that reduce driver error. Given that more than 90 percent of crashes result from human mistakes, the combination of emerging driver assist features, connectivity, and ultimately autonomous vehicles offer the promise of safer mobility, as well as less congestion, less fuel consumption, lower emissions, lower insurance costs, and higher productivity.

We see a robust debate in the press, mostly with engineers who agree with each other less often than lawyers, about when self-driving cars will become a reality. That is the wrong question. It makes safety about some magic moment in the future rather than

recognizing that technologies in the marketplace today already are providing important benefits as they set the foundation for tomorrow.

The premise of today's hearing is that technology will yield highly material safety benefits for American drivers. That invites two questions: one, what are the barriers inhibiting the rate of life-saving innovation, and what can you do to speed innovation in light of these barriers.

Ironically, technology is not the biggest obstacle to deploying innovation. Rather, the bigger hurdles are, one, consumer acceptance, two, product liability, three, connectivity, and four, fleet mix concerns. Our polling shows that consumers strongly equate technology with safety, and that is very promising. But at least for now, these same consumers are dubious about self-driving vehicles, splitting four to three against the view that autonomous vehicles are a good idea. The driving experience is deeply ingrained. Non-incremental change is scary.

Liability is a huge problem, especially when aftermarket solutions become available. Who is responsible if something fails? What if a garage inventor produces a flawed at-base solution? If liability flows inappropriately to the OEM, we would see higher product costs, chilled innovation, and probable reduction to manufacturing employment.

Connectivity is a critical component to safety progress, as we have discussed. For full V2V and V2I connectivity, spectrum integrity and investment in infrastructure are vital. Without it, long-term driver technologies cannot realize their potential.

Finally, how would we handle fleet mix challenges? We often focus on the length of the industry's product cycle. The more salient factor is the consumer cycle. Eleven is the age of the average car on the road. We only turn over the fleet—half the fleet in roughly a decade. Thus, at any given point in time, we have a wide range of technologies on the road with different crash mitigation and different crash prevention profiles.

So we have some recommendations. I would make these five. First protect the spectrum. The most time sensitive recommendation to a safety first future is ensuring that the 5.9 gigahertz radio frequency, now dedicated to V2V and V2I, remains solely available for safety critical communications. When two tons of metal are moving 100 feet per second, communications must work instantly and accurately.

The FCC is now considering opening up a portion of the spectrum, as we have discussed. The Agency should adopt a do no harm strategy until testing is complete, and we are concerned that the NTIA report is due after the FCC is likely to reach a judgment.

Second, invest in infrastructure. Robust and life-saving connectivity requires infrastructure build out that is costly to communicate with vehicles. This will be a gradual process because of the cost. But we need the vision and the motivation to begin planning and implementing today.

Third, address consumer acceptance. We have to get ahead of potential public concerns before we deploy. We will need to tackle a range of tricky questions that are critical outside and inside the

car, including privacy, security, and comfort with new technologies. Building consumer trust is imperative.

Fourth, maintain vehicle affordability. Public policy should keep vehicles as affordable as possible by leveraging market forces and letting data drive regulation. The best technology in the world does nothing if cars are stuck in a showroom because of mandate overload. Cars are lasting longer, and new cars cost more than $30,000 a unit. We only replace about 6 percent of the U.S. car park annually. Any policy that slows the replacement cycle may compromise the greater good.

And finally, fifth, we need to preserve technology neutrality. We all recognize the challenge of distracted driving. You have talked about it with Mr. Strickland in detail. That challenge has grown as connectivity has found its way into cars.

The NHTSA guidelines are illustrative. Here, government policy calls for restrictions of functionality of the built-in systems without corresponding limitations of the portable devices. The result: chilling innovation of the built-in system and incentivizing the hand-held use. So if a driver is looking for live nav guidance and they cannot plug it in their own system, what do they do? Oftentimes they pull out their iPhone or their Android, they look down below the dash, they plug in the address, they fiddle with the keys, and potentially suffer the consequences. We cannot wish the real world away. A policy that is not comprehensive across technologies and across devices produces unintended consequences.

So to close, the promise of future mobility has never been brighter or safer. We stand ready to work with this committee to maximize innovation and to save lives, and we thank you for the opportunity to testify.

[The prepared statement of Mr. Bainwol follows:]

PREPARED STATEMENT OF MITCH BAINWOL, PRESIDENT AND CEO, ALLIANCE OF AUTOMOBILE MANUFACTURERS

On behalf of the twelve automakers who are members of the Alliance of Automobile Manufacturers (Alliance),[1] thank you for this opportunity to testify today on our successes in enhancing vehicle safety and the promise of emerging technologies for the future of mobility.

For more than a century, innovation in automotive mobility has been our guidepost, producing technological advances leading to safer, cleaner, more energy-efficient cars and light trucks.

Now, looking down the road, personal transportation is poised to undergo revolutionary change, as dramatic as the introduction of the first cars on our roads. Those first vehicles changed society by connecting people to markets, to health care, and to schools.

Before us lies the potential to dramatically reshape the driving experience and redesign the whole concept of personal mobility through the combination of sensor-based safety systems, intelligent driving, driving assist systems and communications-based connected vehicle technologies.

The vision for the future is nothing less than amazing. New technologies and systems will continue to provide enhanced safety benefits, reduce environmental impacts, reduce congestion and improve our quality of life in countless ways.

A review of the road already traveled demonstrates how much road safety progress has already been achieved.

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[1] Alliance members include BMW Group, Chrysler Group LLC, Ford Motor Company, General Motors, Jaguar Land Rover, Mazda, Mercedes-Benz, Mitsubishi Motors, Porsche, Toyota, Volkswagen Group of America and Volvo. Alliance members account for roughly three quarters of all vehicles sold in the U.S. each year.

Historically, automakers have focused on engineering vehicles to enhance occupant protection in the event of a crash. Today, automobiles have a range of airbags—front, rear, side and even curtains—as well as a long list of safety enhancements, from structural reinforcements to the passenger compartment to advanced safety belts. Many of these advances were designed and introduced by the auto industry voluntarily, without any government mandate.

Our progress was recognized by the Centers for Disease Control and Prevention, where experts described the results of automotive safety advancements as one of the ten "Great Public Health Achievements" of the 20th century.

And we are continuing to see progress in this century. In 2011, the number of traffic fatalities was over 25 percent lower than in 2005. Moreover, the fatality rate per 100 million vehicle miles traveled showed a similar decline since the beginning of the 21st century. However, a preliminary statistical projection by NHTSA estimates that over 34 thousand fatalities occurred in motor vehicle traffic crashes in 2012—an increase of 5 percent compared to 2011. So, there is more work to do.

What are some of the principle challenges to road safety today?

During the period 1997 to 2011, motorcycle deaths have more than doubled, from about 2,000 to around 4,600, while overall traffic fatalities fell in the same period by 23 percent. It now appears motorcycle deaths may exceed 5,000 in 2012, accounting for over 14 percent of all traffic fatalities. More must be done.

Despite our many efforts, about 1 in 7 Americans still is not buckling up. In recent years, about half of the passenger vehicle occupant fatalities were unbelted. NHTSA estimates that safety belts saved nearly 12,000 lives in 2011. The agency further estimates that increasing safety belt usage to 100 percent would save more than 3,000 lives each year. Many automakers are installing seat belt reminder systems to encourage drivers and passengers alike to buckle up.

Driver error is an overarching challenge to making our roads safer. NHTSA estimates that driver error is involved in more than 90 percent of crashes.

Impairment is a leading cause of driver error. Eliminating impaired driving would reduce by one-third the number of people who die on our roads each year. The Alliance supports requiring alcohol interlock devices for convicted drunk drivers. In addition, for the past five years, Alliance members have been working in partnership with NHTSA to research advanced in-vehicle technology called "DADSS"—technology that holds promise to help eliminate drunk driving one day. The Alliance appreciates the leadership role taken by this Committee last year in continuing to fund this critical research during the reauthorization of surface transportation.

Novice drivers are another source of driver error. Novice drivers generally tend to make more mistakes than experienced drivers. New driver education and training can help minimize the risk. We know motor vehicle crashes are the number one cause of death and injury among youth in this country, which is why the industry has invested in novice driving programs and technologies that help new drivers gain more experience and training behind the wheel.

The future of vehicle safety has expanded into "crash avoidance" technologies that help prevent or mitigate crashes. Crash avoidance, or "driver assist," technologies employ sophisticated software to interpret data from sensors, cameras, or radar-based technologies that allow vehicles to sense the environment around them and assist drivers to become aware of impending dangers, or in some cases may take over for drivers to help prevent or mitigate accidents.

There are about twenty different "driver-assist technologies" available already on today's vehicles, with more coming. You can see them in action on our YouTube channel at *www.YouTube/DriverAssists.*

What do we mean by driver-assist technologies?

Intervention technologies include electronic stability control and anti-lock brakes that help keep the vehicle under control without engagement by the driver. These two technologies are present in virtually every new passenger car sold in America. In addition to these systems, new technologies are being introduced to assist drivers to avoid or mitigate crashes in emergency situations, such as crash imminent braking and dynamic brake support. According to recent data compiled by the Highway Loss Data Institute, vehicles that brake automatically may offer significant safety benefits. Their drivers file 15 percent fewer property damage claims. They are 16 percent less likely to file claims for accidents involving property damage. And, their owners are 33 percent less likely to file claims for crash injuries than the average owners of similar vehicles.

Warning technologies provide alerts to assist the driver, such as blind spot warnings, lane departure warnings, cross traffic alerts, and forward collision warnings. All of these systems provide drivers with additional information to help them take

corrective action to avoid the risk of a crash. However, the driver has the means to operate the vehicle safely without these features.

Driver Assistance technologies include lane keeping systems, adaptive cruise control, and automatic high beams. Drivers decide when to activate these systems, which then may assist the driver during routine driving tasks, provided road and environmental conditions permit.

This year, consumers will be able to visit dealer showrooms to see "gee whiz" technologies such as adaptive cruise control with automatic braking and lane centering. This illustrates a beginning stage in the development of future automated vehicles, which can actively control or position their distance from other surrounding vehicles.

As we move into the future, developing infrastructure and vehicles that communicate with each other has the potential to be a game changer for road safety. According to NHTSA, connected vehicle technology could potentially benefit approximately 80 percent of crash scenarios involving non–impaired drivers. That is why both automakers and the government are investing hundreds of millions of dollars in research, development and testing of connected vehicle technology. Connected vehicles may help to enhance or enable a host of critical crash-avoidance technologies.

The phrase "connected car" has become a bit of a catchall and means different things to different people.

For some, connectivity in the car is about eliminating the gap in access to people or information that occurs when commuting between point A and point B. In our digital world today, drivers and their passengers want to be seamlessly connected to the web and all its functionality, including social media, communications, music, navigation and a range of transportation-related content. They want to be as connected in the car as they are everywhere else.

For others, connectivity in the car is about reducing the potential of crashes by getting information on real-time risk factors outside the vision of the driver—or the electronic eyes of the car. This connectivity refers to the exchange of information either among vehicles—called V to V—or information between vehicles and infrastructure—commonly referred to as V to I.

Automakers view safety, mobility, environment, and road travel convenience applications and functions to be within the connected vehicle scope. Automakers consider other applications connecting people to people and people to businesses as telematics functions.

Whether among cars or with infrastructure, the potential of connected vehicles is mind-boggling. Cars may have the potential to sense if black ice is on the road, if bridges are iced over, or if a crash has occurred on the road ahead—all before the driver can detect the impending challenge. With connectivity, the driver can be alerted to take precautionary measures—and the car itself may be able to use connected vehicle data, in combination with other vehicle sensor data, to perform a range of anticipatory countermeasures like precautionary braking or seat belt tensioning to address the looming risk. Or the car may be able to direct the driver to an alternate roadway to avoid the situation entirely.

The future of driving safety is very bright, and with the right public policies put in place to support connectivity and the replacement cycle, working together industry and government can support the goal of increasingly safe mobility. Getting there will require many pieces of a large puzzle to fit together in addition to technological advancements: consumer acceptance, achieving critical mass to enable the "network effect," and establishment of the necessary legal, regulatory framework and other policy issues. We can get there from here.

Surveys of consumers' attitudes involving advanced technologies and automated vehicles conducted for the Alliance indicate that a majority (59 percent) believe that technological innovations such as driver assist technologies are making cars safer. However, consumers are currently dubious of "self driving" cars with only 33 percent indicating that such cars are a good idea, 42 percent responding they are a bad idea, and 24 percent unsure. Building consumer trust is critical. Drivers are unlikely to cede control of their cars unless they are convinced that automated technology is safe and reliable.

To realize the benefits of connected vehicle technologies, a large network of vehicles equipped with these technologies, or at least capable of working within this network, is needed. An aftermarket system that consumers value, could help to speed establishment of a critical mass of connected vehicles. Establishment of corridors of connected operation may be another means for achieving critical mass where it is most needed, in densely populated urban areas. Finally, greater autonomy of operation dictates greater cooperation among vehicles.

Consideration needs to be given to the needed legislative and regulatory framework needed to spur development and adoption of advanced technologies. A patch-

work of state laws will negatively impact the speed and trajectory of the technologies adopted. Federal leadership is needed to establish a single, long–term national vision for personal transportation in the future. However, care must be exercised to ensure that development is facilitated—not frustrated—while also ensuring that the appropriate performance criteria are established.

Finally, perhaps the most challenging is the resolution of a litany of complex legal issues that are associated with cars and trucks capable of operating with increasing levels of automation. These include insurance underwriting and liability issues. A greater portion of liability may shift from individual vehicle operators and actors to manufacturers and infrastructure providers (federal and state). The question of who is responsible when, for what, will need to be addressed.

We are pleased with the great vision of this Committee in focusing today on the future. Like you, we share the goal of ensuring the public policy pillars necessary to achieve the full safety value of connectivity and other technological advances be identified and protected.

We believe five pillars of policy are central to maximizing safety through technology in the future are: (1) protect the spectrum; (2) invest in infrastructure; (3) ensure consumer acceptance; (4) maintain vehicle affordability; and (5) preserve technology neutrality.

Protect the spectrum: The first pillar is ensuring that the radio frequency spectrum now dedicated to V-to-V and V-to-I—the 5.9 GHz band—remains solely dedicated to auto communications technologies. When vehicles are driving at highway speeds, communications must occur virtually instantaneously, without delay and without interference. The FCC is now considering whether to open this portion of the spectrum for use by unlicensed wireless devices. While we understand the potential benefits of expanding wireless access, regulators must be certain that unlicensed users would not compromise the integrity of this vital safety initiative. The FCC should maintain the spectrum for safety critical systems until thorough testing is completed and all parties are certain that the spectrum remains reliable and secure for its primary V-to-V and V-to-I purpose, and can be shared without interference.

Invest in infrastructure: The second pillar is building out the infrastructure for the V-to-I component of connectivity. Surely this will be a gradual process, but we need the vision and motivation to begin planning today. As is the case with a range of technologies, such as alternative powertrains for environmental gains, infrastructure investment is essential to achieving the maximum safety benefit and inducing buyers to purchase the V-to-I communications functionality.

Ensure consumer acceptance: The third pillar is proactively addressing consumer acceptance by addressing in advance of deployment potential public concerns. If the advent of connected vehicle technology exposes drivers and owners of equipped vehicles to loss of privacy, security breaches, and/or increased legal liability in the form of automated law enforcement, we will not realize the many benefits that might otherwise be gained by its widespread deployment. Similarly, connected and automated vehicle systems entail interactive technologies for which successful outcomes depend not only on drivers' correct response to alerts and information, but on multiple entities in both the public and private sectors correctly and consistently performing their respective portions of the connected enterprise. This creates new and unprecedented challenges that will need up-front policy consideration.

Maintain vehicle affordability: The fourth pillar is keeping cars and light trucks as affordable as possible by leveraging market forces and utilizing a data-driven approach to regulation if and when needed. The best technology in the world can only help if families are able to replace their old cars with new vehicles. Today, the average age of a car is 11 years old, and we only replace about 6 percent of the U.S. car park every year. When the safety (and environmental) benefits of new cars relative to old cars are sizeable, the public policy imperative must be to avoid the temptation to mandate and instead facilitate choices by families in the marketplace. Policies that discourage the purchase of new technologies should be avoided—as a matter of public policy, we need to encourage the "virtuous cycle of new car ownership."

Preserve technology neutrality: The fifth pillar is supporting a comprehensive approach to in-vehicle technologies. Decisions made today can produce dramatic repercussions tomorrow. We all recognize the challenge of distracted driving and how that challenge has grown as connectivity has found its way into cars, primarily through smartphones. The recently issued NHTSA guidelines on distraction are a case in point. In this instance, government policy calls for restrictions in functionality of in-vehicle systems without corresponding functionality limitations in portable devices. As a result, government policy will likely chill innovation and bias drivers toward the use of handheld devices, rather than integrating devices with in-

vehicle systems. So, if a driver looking for live NAV guidance is blocked from doing so while his car is in motion, he may predictably pull out his smartphone, fiddle with the keys while looking down, and retrieve the desired mapping guidance. That's the real world and as much as we might want to wish that away, a policy that isn't comprehensive across technologies and devices and responsive to consumer needs is a policy that will produce unintended and undesirable consequences.

Successful policy will recognize behavioral realities. We have studied smartphone utilization in cars and found younger drivers are especially resistant to abandoning connectivity while driving. Attempts to modify behavior are unlikely to succeed. Rather, NHTSA has it right when it says that the number one goal in distraction policy should be to encourage drivers to connect their phones to the built-in systems which can be controlled by voice and help drivers keep their eyes on the road and their hands on the wheel.

The issues before us are complex. Even the Department of Transportation (DOT) is struggling with information in cars. Under the 511 program funded by DOT and administered by the states, real-time traffic video and tweets are available to drivers to avoid road congestion. That's a good thing. But it also threatens to violate the new distraction guidelines by urging drivers to use smartphones on the road. So, the government is literally driving smartphone use in cars in one program, while castigating their use in another.

The point is not to criticize government. The disconnect within the DOT reveals the complexity of the challenge of managing information in the driving context. As the connected car becomes a reality, we should view information not as a distraction but as a critical foundation to safety technology, especially as driver-assist technologies mature.

NHTSA has regulatory authority over OEMs. The agency believes it has regulatory authority over personal electronic device (PED) manufacturers, software developers and carriers when their technologies are used in cars, although this authority has not been tested. Regardless of the scope of its regulatory authority, it makes sense for NHTSA to bring all the stakeholders together to forge a new set of voluntary guidelines that are neutral across technologies, provide consumers with the functionality they demand and move behavior away from PEDs and to in-vehicle systems that help keep the driver's eyes on the road and hands on the wheel.

We are living in an extraordinary moment in the history of mobility. Over the next decade, automakers will put about a billion new cars on the roads around the world—about 150 million of them in the U.S. However, it is important to understand that, given the size of the in-use fleet and the longer life cycles of today's vehicles, roughly half of the cars that will be on the road in 2025 have already been sold and put into service. Thus, deployment throughout the fleet will be relatively gradual even though technology improvements may be rapid. And that suggests that the fleet mix of the in-use fleet will reflect a wide range of driver-assist technologies and connectivity for years to come.

Now, just for a second, ponder the implications of cars that rarely crash. More lives will be saved. Congestion caused by crashes will become far less frequent. Fuel requirements will drop as traffic flows more quickly—and cars become lighter. Additionally, insurance rates will fall with the reduced incidence of fender benders and crashes. Working together, we can make this vision reality.

Many thanks for this chance to share our perspective.

The CHAIRMAN. Thank you, sir.

And now, Mr. Jeffrey Owens.

STATEMENT OF JEFFREY J. OWENS, CHIEF TECHNOLOGY OFFICER AND EXECUTIVE VICE PRESIDENT, DELPHI AUTOMOTIVE

Mr. OWENS. Thank you, Chairman Rockefeller, Ranking Member Thune, and members of the Senate Commerce Committee for the opportunity to testify before you today on behalf of Delphi Automotive.

As Chief Technology Officer, I am responsible for Delphi's innovation strategies as well as research and development focused on safe, green, and connected societal megatrends. As a leading global supplier of electronics and technologies for automotive, commercial vehicle, and other market segments, Delphi invests $1.6 billion an-

nually into global R&D initiatives, and employ about 5,000 people in the United States.

If I could leave you with one message today, it would be this: 11,000 lives can be saved annually without a technology mandate, without a broad new program, and without regulatory requirements.

Every 30 seconds, there is a vehicle-related death somewhere in the world, and that equates to about 1.2 million people who die each year. That is a tragedy, and it can be prevented. The World Health Organization projects traffic injuries to be the fifth leading cause of death by 2030, even more than AIDS or cancer. And while vehicle deaths in the United States have declined with widespread adoption of passive safety technologies, such as seatbelts and airbags, progress toward further death and injury reduction has stalled, resulting in more than—about 33,000 deaths annually in the United States, and 200,000 serious injuries each year on our roadways. Additionally, crashes continue to be the number one cause of death for people ages four to 34, and we know—we heard earlier over 90 percent of accidents are caused by driver error.

Although passive safety technologies, like seat belts, have helped more people survive crashes, we think the next frontier of safety is to prevent the accidents before they occur. Active safety technologies are the key to reducing accidents, injuries and deaths. Government and industry groups have studied the benefit of these technologies for over a decade. A study by the Insurance Institute for Highway Safety states a 31 percent reduction in deaths is possible. And once again, that is more than 11,000 lives saved per year with full deployment of active safety systems across the vehicle fleet. I am talking about forward collision warning with collision imminent braking, lane departure warning, blind spot detection.

The driving public wants vehicles with improved safety features. No doubt, safety sells, but technologies are currently available, and it is difficult for consumers to understand their value. A key consumer awareness tool is the New Car Assessment Program, or NCAP, which includes the star rating system on all new vehicle window stickers.

Now today, NCAP is not structured to accommodate active safety vehicle options. Delphi is recommending to the Committee and to NHTSA that the U.S. amend the NCAP to require star ratings for active safety collision avoidance technology, and that it be incorporated into the window sticker on new cars in the future.

Now we are talking about mature technologies that have been on the road since 1999. They are ready to deploy in high volume, and that will result in fewer accidents and deaths. Many of these technologies are commercially available, but relatively few vehicles are equipped with them. At the current rate of acceptance, active safety technologies will not significantly impact crash statistics for about 20 years. We suggest that NHTSA focus on proven technologies, such as collision imminent braking and lane departure warning for inclusion in the NCAP five-star certification.

Now, there is no need to mandate measures or choose technology winners and losers here. The best path forward is to provide consumers with information in a form that they can use and to which the market will respond. The sooner we increase consumer aware-

ness, the sooner we experience lower fatality rates. With opportunities for distraction increasing, the convergence of connectivity and active safety technology is critical to allow safe connectivity and still allow drivers to keep their eyes on the road, their hands on the wheel, and their mind on the mission, and that is the mission of driving safely.

Technology like Delphi's industry-first, integrated radar and camera system combines radar sensing, vision sensing, and data fusion in a single module. Similarly, our rear and side detection system helps make drivers aware of approaching vehicles while changing lanes or making turns by providing an alert when a vehicle has entered a blind spot of the vehicle. Our active safety human machine interface helps keep drivers connected to the information they want while mitigating driver distraction. It helps ensure the vehicle is never distracted, even if the driver is.

So in conclusion, we are at a critical point in the automotive industry. Consumers are demanding this 24/7 connectivity, and this dynamic directly impacts safety on America's roads every day. At Delphi, we believe the foundation for safer driving is the robust deployment of active safety technologies.

Thank you for the opportunity to address the Committee.

[The prepared statement of Mr. Owens follows:]

PREPARED STATEMENT OF JEFFREY J. OWENS, CHIEF TECHNOLOGY OFFICER AND EXECUTIVE VICE PRESIDENT, DELPHI AUTOMOTIVE

Thank you Chairman Rockefeller, Ranking Member Thune and members of the Senate Commerce Committee for the opportunity to testify before you today on behalf of Delphi Automotive.

My name is Jeff Owens, and I am Chief Technology Officer and Executive Vice President for Delphi Automotive. I am responsible for Delphi's innovation strategies as well as leading development of the company's advanced technologies focused on Safe, Green, and Connected societal megatrends.

As a leading global supplier of electronics and technologies for automotive, commercial vehicle and other market segments, we invest approximately $1.6 billion annually into research and development initiatives. In the U.S., Delphi operates major manufacturing facilities, technical centers, and administrative facilities in Michigan, Mississippi, Indiana and New York that employ approximately 5,000 people. Delphi's technology portfolio places us at the center of vehicle evolution and innovation, making products smarter and safer as well as more powerful and efficient.

Given our proven expertise with market-leading original equipment manufacturers (OEMs) around the world and our broad automotive systems capabilities, we welcome the invitation to testify at this important hearing on Advanced Vehicle Technology and its Implications.

This is an amazing time to be in the automotive space. As a Tier 1 vehicle technology supplier, we work closely with our customers, automotive companies, to develop capabilities in vehicles demanded by consumers. This effort has linked Delphi with many mobile technology suppliers. In addition, Delphi works with thousands of suppliers, who provide raw materials and components for our increasingly complex and sophisticated components and systems. All of this is accomplished in a compressed time-frame from conception to market. Delphi and the automotive supply industry has adapted to this innovation challenge by focusing on our customers' needs by offering relevant solutions. It is becoming increasingly important, however, that consumers have ready access to the most current information on the attributes that make a vehicle safe.

Delphi identified the megatrends of *Safe, Green and Connected* as the issues that would be most relevant to today's drivers and particularly our OEM customers. Today's focus is narrowed to two of those three measures, *Safe and Connected.* We would be happy to address global megatrends related to clean and efficient powertrain (Green) at a future time.

Right now, we are witnessing a convergence of issues. Consumers are increasingly demanding to be connected in their vehicle, while regulators are demanding that

they connect safely. I would like to take time this morning to briefly outline for you how Delphi is developing advanced technologies to address these megatrends and what it means for the future of our roadways. I think you will see there are technologies that will virtually change the automotive landscape.

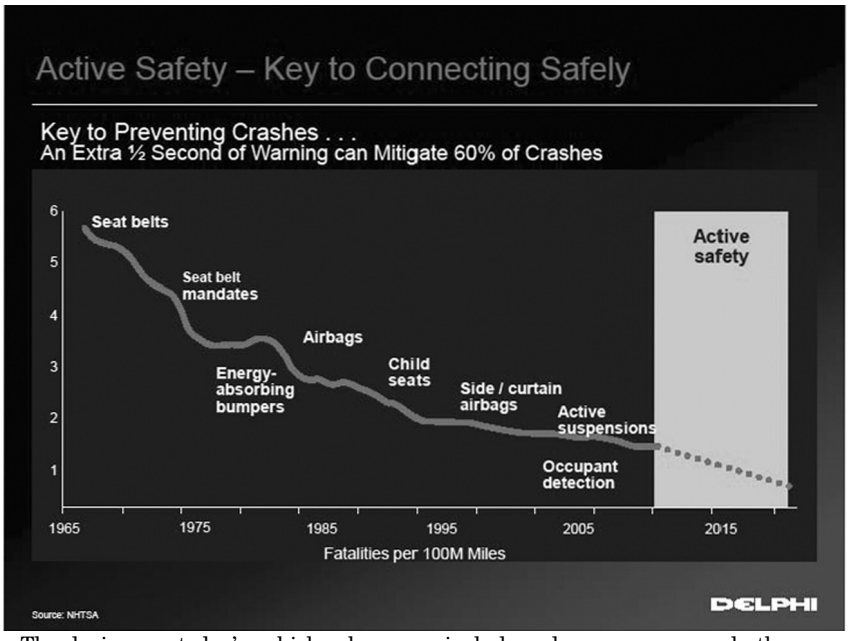
I'll begin with *Safe*.

Every 30 seconds, there is a vehicular fatality somewhere in the world. That equates to 1.2 million people who die worldwide each year. It's a tragedy, and can be prevented. According to the World Health Organization, traffic injuries are projected to be the fifth leading cause of death worldwide by 2030—surpassing HIV/AIDS, cancer, violence and diabetes. The impact is not just on lives lost, but on our global economy. Here in the United States, vehicle fatalities have declined with the use and widespread adoption of passive safety technologies such as seatbelts and airbags. However, progress toward further fatality and injury reduction has stalled, allowing over 33,000 fatalities annually in the US, and more than 200,000 serious injuries each year on our roadways. Additionally, vehicular crashes continue to be the number one cause of fatalities for people ages 4 to 34, with over 90 percent of accidents caused by driver error. The financial impact is also staggering, with one study estimating the total annual cost of road crashes in the United States alone to be over $231 billion.

Although passive safety technologies like seat belts have helped more people survive crashes, we firmly believe that the new frontier of safety is to prevent accidents before they happen with Active Safety technologies, and we have worked hard to lead the way in this area.

Passive and Active Safety

Delphi is a leading global supplier of passive safety equipment as well as Active Safety technologies that can sense the environment outside the vehicle and inform the driver of imminent threats. Passive safety has resulted in significant reductions in injuries and death on U.S. roads. Delphi is proud to have been a pioneer in these products, including seat belts, airbags, energy absorbing bumpers, active suspension and occupant detection systems, to name a few.



The devices on today's vehicles, however, include radars, cameras, and other sensors that can provide a full 360 degrees of sensing coverage around the vehicle. In addition to warning the driver of potential accidents, Active Safety systems can also react when drivers cannot, applying vehicle braking or steering automatically to help avoid or reduce the severity of accidents.

Active Safety technologies are the key to reducing accidents, injuries, and fatalities on our roadways. Government and industry groups have studied the benefit po-

tential for these technologies for well over a decade. In particular, a recent study by the Insurance Institute for Highway Safety (IIHS) states a 31 percent reduction in fatalities is possible with full deployment of Active Safety systems across the vehicle fleet, namely, Forward Collision Warning with Collision Imminent Braking, Lane Departure Warning, and Blind Spot Detection. This reduction amounts to a potential savings of over 11,000 U.S. lives per year.

As we discussed, the driving public is very interested in buying cars with improved safety features. There are numerous technologies currently available, but it is relatively difficult for consumers to decipher the value of various safety technologies. One of the best consumer tools is the New Car Assessment Program, or NCAP—which includes the star rating system on all new vehicle window stickers.

Unfortunately, NCAP is currently not structured to accommodate active safety vehicle options. That is why Delphi is recommending to the Committee and to NHTSA that the U.S. amend the NCAP to require star ratings for active safety collision avoidance technology to be incorporated into the window sticker in the future. These are mature technologies that have been on the road since 1999 and are ready to deploy in high volume, resulting in greater consumer awareness and choice, and a reduction in accidents and fatalities. Many of these technologies are commercially available, but relatively few vehicles are equipped with the technology. At the current rate of acceptance, it is estimated that active safety technologies will not significantly impact crash statistics for 20 years.

Enacting an NCAP star rating for active safety by 2015 would help save lives on the Nation's roadways. Focusing on Collision Imminent Braking (CIB) and Lane Departure Warning (LDW), at least for initial ratings will help drive consumer awareness and choice as well as enable technology for future autonomous vehicles. Accelerating the development and deployment of these technologies is key to preventing accidents, reducing injuries, reducing health care costs, addressing driver distraction and ultimately saving lives. I don't envy the job that NHTSA has to keep pace with this dynamic marketplace. But it's critical that they focus on the active safety technologies that have the most potential to reduce fatalities on our Nation's roadways, including forward collision warning with collision imminent braking, lane departure warning, and blind spot detection.

There is no need to mandate measures or choose technology winners and losers. The best path is to provide consumers with information in a form that they can use and to which the market will respond. And the sooner we provide these choices, the sooner we experience lower fatality rates on our Nation's roadways.

Connected

Today, there are one billion smartphone users globally. That translates into more consumers demanding to stay connected, even in their vehicles. Not only are consumers buying more smartphones, they are also accessing more content—via Twitter, Facebook, Instagram. Consider this: Facebook hit 1 billion users last year—70 percent of whom access their account from a mobile device!

Certainly there are situations where connectivity has been proven to save lives. Emergency alerts, automatic 911, even global positioning systems (or GPS) make driving and drivers safer. This trend will likely continue as technology becomes more mainstream, allowing motorists to communicate with roads to improve traffic flow and navigation.

But with opportunities for distraction increasing, the convergence of connectivity and Active Safety technology is critical to allow *safe* connectivity, keeping drivers'

- Eyes on the road
- Hands on the wheel, and
- Mind on the mission—the mission of driving safely

Delphi's industry-first, integrated Radar and Camera System (or RACam) combines radar sensing, vision sensing and data fusion in a single sophisticated module. Similarly, Delphi's Rear and Side Detection System (RSDS) helps make drivers aware of approaching vehicles when changing lanes or making turns. By providing an alert when a vehicle has entered a blind spot to the rear or side of the vehicle, RSDS helps give drivers more time to react to obstacles that may be difficult to see in the side mirror. Our Active Safety human-machine interface (HMI) helps keep drivers connected to the information they consider important while helping to mitigate driver distraction.

In conclusion, we are at a critical point in the vehicle technology industry. 24/7 connectivity is prominent and happening all around us. Market studies indicate that consumers will pay for connectivity—and will pay to use it safely. These dynamics have significant potential to impact the way we move about on America's roads

every day. At Delphi, we firmly believe that first step, the foundation for safe connectivity, is the robust deployment of active safety technologies.

Delphi believes that Active Safety technologies hold great promise. And that's why we have invested heavily in engineering and technology research. We stand ready to assist this Committee as you forge the road ahead in advanced transportation technology, and I'll be happy to answer your questions.

Again, thank you for the opportunity to address the Committee.

The CHAIRMAN. Thank you, sir.

And now, Mr. Peter Sweatman, Director, the University of Michigan Transportation Research Institute.

STATEMENT OF DR. PETER F. SWEATMAN, DIRECTOR, UNIVERSITY OF MICHIGAN TRANSPORTATION RESEARCH INSTITUTE

Dr. SWEATMAN. Good afternoon, Mr. Chairman, Ranking Member, and members of the Committee. I am honored to speak with you about new technology in vehicles and about a truly safe and efficient roadway transportation system. This system is of transformational importance for the citizens and economy of the United States.

The University of Michigan Transportation Research Institute, UMTRI, is currently overseeing a mobile deployment in Ann Arbor as we heard earlier. We are testing nearly 3,000 cars, trucks, transit buses, and motorcycles. They are equipped for licensed wireless communication, enabling very promising crash avoidance systems. This work is sponsored by the U.S. Department of Transportation, and is carried out in partnership with the intelligent transportation industry, including automotive manufacturers.

I know of no other technology that could have the same impact overall on safety. It has the potential to revolutionize our transportation system by drawing drivers' attention to risks more immediately and more reliably. Pervasively, this will help us all to avoid crashes and to utilize roadways and energy sources much more efficiently.

As we move beyond the research phase, a national ITS strategy is needed to guide the deployment of the 5.9 GHz platform benefiting all road users. We need dedicated short-range communication at 5.9 for all classes of vehicle and at key infrastructure locations. Despite the growing spectrum demand for unlicensed uses, sufficient bandwidth must be protected for exclusive use by vehicles and infrastructure. Reliable and secure communication is non-negotiable.

Cybersecurity is one of the leading issues of our era. A comprehensive strategy involving industry and government must be established and carried out. Further field testing of a new generation security system is needed to ensure that the platform remains secure while maintaining the privacy of all users. Once these systems are developed, we need automotive consumers to embrace them, and we need attractive aftermarket devices widely deployed.

But clearly, a further wave of technological development will occur in vehicle automation. Then the benefits will reach well beyond safety. The scale of the transformation is important. The United States has the opportunity to leap ahead in mobility technology supporting an improved way of life and new mobility industries. An industrial ecosystem with new jobs will be created by the

automotive and information technology industries, and there will be many winners across different businesses and consumers.

So how do we prepare for and sustain this transformation? A critical requirement is for all vehicles, manual or automated, to be connected during a multi-decade transition, and connected vehicles connect with drivers. The need for human machine interface technology to focus the driver's attention is crucial. As we move forward, vigilant technology will draw attention to risky driving scenarios. Even so, the driver will still need to take over in certain situations.

Here are four additional things that must occur. To start, the United States must take the lead in standards development and decide where mandatory safety standards are needed, and where open standards are needed for the Nation's entrepreneurs. Second, voluntary performance standards need to be solidified for the connected vehicle platform, for vehicle sensors and controls.

Third, we need to start now with connected infrastructure. The operation of the roadway infrastructure will change dramatically as more automated vehicles are deployed and co-exist with conventional vehicles. Automated cars someday will be capable of operating in narrow lanes much closer together, and may park themselves without a driver. Finally, national policy positions are needed on data ownership, access, and privacy so that traffic system managers maximize the connected vehicle data.

Obviously we will face new risks with large scale transformation of our ground transportation systems, but the rewards are huge, including an expanded 21st century mobility economy with minimal safety and public health impacts and sustainable energy use. Testing and certification need to be taken to the next level, and responsibility for safety needs to be redefined so that liability concerns do not stall deployment.

In closing, the mobility technologies of the future will emerge through a process built around connected vehicles, automated vehicles, smart infrastructure, and improved driver interaction with the automobile.

I do appreciate this opportunity very much and welcome your questions. Thank you for your attention.

[The prepared statement of Dr. Sweatman follows:]

PREPARED STATEMENT OF DR. PETER F. SWEATMAN, DIRECTOR, UNIVERSITY OF MICHIGAN TRANSPORTATION RESEARCH INSTITUTE

Good afternoon, Mr. Chairman, Ranking Member, and members of the Committee. I am honored to speak with you about key steps for creating a much safer and more efficient roadway transportation system through new and emerging vehicle technologies. My perspective is research, development and deployment, and how to maximize the benefits of new technologies for the citizens and economy of the United States, with world-wide application.

I shall talk about the most promising technological advances with the broadest scope for application, under the shortest time frames. My commentary will include current vehicle technologies and trends as well as the more transformational technologies on the horizon. I shall also talk about how we need to get the job done through coordinated technology development, purposeful deployment, and strong policy guidance. We have entered a transformational period, and need to plan for new technologies and their likely implications for public policy.

Our journey with advanced vehicle technology began when attention moved from systems that protect people involved in crashes to systems that help prevent crashes in the first place.

Such avoidance systems currently alert drivers and are beginning to assist drivers by indicating the appropriate avoidance action. But ultimately the driver is still totally responsible for taking action to avoid the crash. We need more incentives and standards for the performance of such systems, as well as independent data that quantifies the effectiveness of these "safety content" features already being used in the U.S. vehicle fleet.

At the same time as these very positive advances in vehicle safety content are being realized, we are seeing an even stronger move to infotainment and telematics in vehicles, particularly the ability to connect and use personal devices in vehicles. For example, we are seeing a mature level of usage of navigation and traffic information systems, and such systems are migrating from those installed by original equipment manufacturers to those available in smartphones. Telematics services also include personal communication (often with voice command), emergency assistance, and even smart insurance and energy management. Such services connect the vehicle with the cloud, increasing the range and power of available information being channeled to the vehicle.

We are seeing unprecedented attention to the human-machine interface in vehicles, in order to deal safely with the increased flow of information to the driver, and to minimize distraction. Increasingly, such interfaces may be customized by automakers, providing them with some control over the presentation of content entering the vehicle via personal devices, but not the content itself. Responsibility for the safety of these in-vehicle transactions with the driver is an interesting question. Because a range of manufacturers and service providers combine to produce telematics, a "chain of responsibility" approach is needed for safety.

While good design of physical interfaces can minimize distraction, distraction is primarily a human issue that extends beyond vehicle technology. The ultimate solution to distraction is to completely replace human control with elements of automation, although this will not happen for many more years. In the meantime, responsible design is essential. Responsible design includes smart interfaces that can limit access and interfaces that maintain eyes on the road and hands on the wheel.

As we move forward, the technology will increasingly draw attention to risky driving scenarios as they develop. This will apply whether we are talking about the manual driving of today or the automated driving of the future, where the driver will still need to take over in limited situations. There is no better technology for purposefully identifying risky driving scenarios than 5.9 GHz Dedicated Short Range Communication (DSRC) connected vehicles.

The University of Michigan Transportation Research Institute (UMTRI) is currently overseeing a model deployment of nearly 3,000 cars, trucks, transit buses, motorcycles and bicycles in Ann Arbor—these vehicles are equipped for standardized and licensed 5.9 GHz wireless communication enabling very promising crash avoidance systems. This work is sponsored by the U.S. DOT and is carried out in partnership with the automotive and intelligent transportation systems (ITS) industries, and their technology suppliers.

This connected vehicle technology has the potential to revolutionize our transportation system, by drawing drivers' attention to risks more immediately and reliably, providing protection in cases when driver attention is deficient, and giving drivers more time to react. Pervasively, this will help us all to avoid crashes and to utilize roadways and energy sources much more efficiently. *I know of no other technology that could have the same impact on safety, and potentially in a reasonably short time frame.*

And this technology will undoubtedly have very positive impacts on mobility, energy use, and environmental aspects of our transportation system, all of which will provide significant economic benefit to the United States. Our transportation system will not remain internationally competitive without it.

A golden era of automotive safety is within reach. The focus must be deploy the connected vehicle technology, while ensuring that it is reliable and secure, and bring about a rapid uptake by automotive consumers.

We need to fully utilize and deploy Dedicated Short Range Communication (DSRC) at 5.9 GHz for all classes of vehicle and at key infrastructure locations (for example, intersections, interchanges and curves). DSRC is equally effective for—and must be applied to—all modes of roadway transportation, and in fact all road users. A national ITS strategy is needed to guide the application of the 5.9 GHz platform to all vehicle classes and recommended infrastructure locations, benefiting all road users. Testing also needs to be done to understand how this spectrum can serve to protect vulnerable road users, including pedestrians and bicyclists. Furthermore, this is a technological advancement that is being realized and explored by vehicle manufacturers and governments around the world because of its great promise.

The current V2X platform, which has been developed mainly through vehicle-to-vehicle (V2V) R&D, needs to be deployed taking advantage of vehicle-to-infrastructure (V2I) connectivity. Infrastructure is a critical component of connected transportation. Consider the important category of roadway intersection safety. Intersection crash risks are more effectively recognized by combining the "fixed" viewpoint of the intersection with the "dynamic" viewpoint of the moving vehicle. We need a national strategy for vehicle-to-infrastructure communications.

The effectiveness of V2X relies on the shared use of data between vehicles, infrastructure, and devices. But inherently there is risk for any one manufacturer when the safety of their product is partially dependent on another manufacturers product. There will be a wariness to introduce these technologies in the United States due to our litigious climate. Other countries may very well benefit first from the technologies developed here. Because of this, it will be necessary to consider shared-liability regimes, including limiting the liability of automakers and other device makers.

The 5.9 GHz spectrum itself must be managed in such a way that V2V and V2I applications continue to function with full effectiveness, reliability and security, regardless of the burgeoning demand for spectrum for unlicensed uses. Safety trumps convenience. Sufficient bandwidth must be protected for exclusive use by vehicle and infrastructure, to ensure safe and secure communication. Any competing uses need to be sufficiently defined, and testing must be carried out to ensure that safety functionality is not diminished or impaired by any shared bands adjacent to the exclusive safety and security bands. Reliable and secure communication is non-negotiable.

The overall reliability of the V2X platform will depend critically on these exclusive 5.9 GHz bands, as well as the ability of the V2X platform to scale up to large numbers of vehicles in the vicinity. Further testing needs to be carried out to allow for the high traffic volumes and densities of the future, as well as longer-range DSRC deployments.

Nothing is more critical to the success of the V2X safety platform than cybersecurity. Further field testing of a new generation security system is needed to ensure that the platform remains secure, while maintaining the privacy of all users, under all conditions encountered in a full scale field test. And cybersecurity for vehicles in general is an area of growing awareness and concern, and a comprehensive strategy involving industry and government must be established and carried out.

In order to accelerate the uptake of the platform by automotive consumers, it is essential to provide infrastructure-based functionality that offers useful applications to users from day one. This needs to be part of the national ITS strategy. Equally importantly, attractive aftermarket devices, developed with the active support of the automotive manufacturers, are needed to expand access to safety and mobility benefits and increase the density of deployment of the platform. These devices will need to have the active support of automakers. Further field testing of aftermarket devices will also be needed.

Clearly, a further wave of technological development will occur in vehicle automation. Automated vehicles will develop partly from current experimental self-driving vehicles, and will also build upon a successfully-deployed connected vehicle and infrastructure platform. Automation will occur progressively and in stages of decoupling from the driver. Automation will also increasingly affect the layout and operation of the roadway infrastructure.

Automated vehicles will result from a convergence of current driver assistance technology, the connected vehicle and infrastructure platform, and self-driving vehicle technology, including advanced vehicle-based sensors. But automation will also be part of a larger transformation to a new 21st Century Mobility System. Other elements of this transformation are likely to include a new transportation service economy, multi-modal trips, shared vehicle use, alternative energy sources including electrification, data-intensive system management and more tailored vehicles built with new materials and manufacturing techniques.

The scale of the transformation is important. The United States has the opportunity to leap ahead in mobility technology supporting an improved way of life and new mobility industries. An industrial ecosystem will be created by the automotive and information technology industries and there will be many winners.

Our new mobility system will need to operate on, and make highly efficient use of, our existing roadway network. Automated cars will be capable of operating in narrower lanes, with much reduced headways, creating much more efficient use of roadway space. And they may park themselves without a driver.

As part of the need to reduce the cost of the infrastructure, the stresses placed on roadways and bridges by large freight trucks will need to be reduced substan-

tially. A productive new system of less driver-intensive, modular, close-headway freight units will help lead the way in vehicle automation. Traffic system management will utilize extensive data generated through the connected vehicle and infrastructure platform.

The operation of the roadway infrastructure will change progressively as more automated vehicles are deployed and co-exist with conventional vehicles. Eventually, the usage of our infrastructure will change dramatically as cars and trucks are provided with more effective traffic lane configurations and conventional vehicles become the minority.

How do we prepare for, and sustain, this transformation?

The problems we have been working on are the right problems for the long haul. A critical requirement is for all vehicles, whether manual or automated, to be connected during a multi-decade transition. And connected vehicles provide the all-important connection with drivers. Connecting all elements of roadway transportation—vehicles, drivers and infrastructure—represents an historic step forward and a vital platform for innovation.

The need for *human-machine interface (HMI) technology* to focus the driver's attention is a core competency today, tomorrow and the day after. As we move forward, vigilant technology will draw attention to risky driving scenarios. And the driver will still need to take over in certain situations.

The United States must take the lead in *standards development* and decide where mandatory safety standards are needed and where open standards are needed for the Nation's entrepreneurs.

Voluntary *performance standards* for vehicle safety systems are well advanced and need to be solidified for the connected vehicle platform, vehicle sensors and controls.

We need to start now with connected infrastructure. Changes in the operation of the *roadway infrastructure,* as more automated vehicles are deployed, will eventually be profound. These changes will be driven by timely and reliable operational data, driven by connected vehicle data sources. National policy positions are needed on *data ownership, access, and privacy.* Traffic system managers need guidance in order to exploit the extensive data generated through the connected vehicle and infrastructure platform.

What new risks do we face with a large-scale transformation of our ground transportation systems? The rewards are huge, but do bring new security risks.

We are on the threshold of a very large-scale transformation of our ground transportation systems. We are now moving towards a system that will achieve much more for our consumers and industries, and create a new mobility economy, with minimal safety and public health impacts, and sustainable energy use.

The huge rewards of the new mobility system will also entail new risks that must be dealt with. Automated, high-density movement at speed has the potential for large scale disruption and harm as a result of systems malfunction, cyberattack or human error. We will need to be willing to develop breakthrough capabilities in the testing and certification of automated systems, cybersecurity, and human machine interface design. Responsibility for safe operation will need to be shared by industrial partners in such a way that none bears an unreasonable level of liability.

National strategies, performance standards and testing requirements for the connected vehicle and infrastructure platform, vehicle sensors, levels of automation, and HMI will be required.

Attention in the form of policy or legislation will be needed to the assignment of responsibility for safe vehicle operation. This will transfer from the driver towards the vehicle manufacturer as levels of automation increase over time. The vehicle manufacturer will carry considerably more responsibility, under conditions of greater uncertainty, including shared data and decision making. It will be necessary to consider a "chain of responsibility" approach, to ensure that the risk is commensurate with the benefit for each party, and to limit the liability of several partners.

Cybersecurity is a new and difficult problem. It will be necessary for the government to convene thought leadership in transportation cybersecurity, develop a defined action plan, and lay out protocols for cybersecurity that address the required level of security, testing standards, updates, and responsibilities of all relevant parties.

In closing, I wish to emphasize that the mobility technologies of the future will emerge through a process built around connected vehicles and infrastructure. Successful new technologies, of national importance, must be accommodated by:

- *National testing, standards and certification for connected and automated vehicles;*
- *Progressive innovation within our infrastructure;*
- *Scientific solutions for engaging driver and machine;*
- *Limited transfer of responsibility for safety, from drivers to private companies; and*
- *A defined action plan and enduring set of protocols for transportation cybersecurity.*

I appreciate this opportunity very much and welcome your questions. Thank you for your attention.

The CHAIRMAN. Is that it, sir? Thank you very much.

Dr. SWEATMAN. That is it. Thank you.

The CHAIRMAN. And then Dr. John Lee, University of Wisconsin-Madison.

STATEMENT OF DR. JOHN D. LEE, EMERSON ELECTRIC QUALITY AND PRODUCTIVITY PROFESSOR, DEPARTMENT OF INDUSTRIAL AND SYSTEMS ENGINEERING, UNIVERSITY OF WISCONSIN-MADISON

Dr. LEE. Chairman Rockefeller, Ranking Member Thune, and the Committee, thank you for the opportunity to speak today. My comments address the human side of vehicle technology.

To put vehicle technology in context, consider driving safety as an important health problem. Approximately 34,000 Americans died in motor vehicle crashes last year. These crashes are the most likely cause of death for those between four and 34 years of age, and account for more than 30 percent of teen deaths. The coming years will bring increasingly complex distractions and increasingly complex vehicles to drivers who may be unprepared for either. This technology can dramatically improve or degrade driving safety.

Vehicle technology affects driving safety because your car is essentially a computer. A typical luxury car requires over 100 million lines of computer code. Software and electronics account for 40 percent of the car's cost and 50 percent of warranty claims. We think of cars as mechanical systems, but they are actually rolling computers.

These computers are changing what it means to drive. They already enable cars to take over many important driving operations with features such as adaptive cruise control, automatic parking, and autonomous braking. Entertainment systems now enable drivers to connect social networks, hear text messages, and choose from thousands of songs. From these changes, a critical safety threat may emerge: the technology automating driving much of the time, drivers have the freedom to focus on entertainment systems, but the vehicle can then unexpectedly hand control back to the distracted driver. Drivers are particularly error prone in such situations. Changing vehicle technology may make such unexpected handoffs even more likely.

Moore's law suggests the capacity of automation and entertainment systems will change rapidly, doubling every 18 months. This exponential increase means that in 15 years we are likely to be discussing whether people should be allowed to drive because the autonomous vehicles may be so much less error prone than people.

Until cars assume complete responsibility for driving, the critical challenge is to design vehicles so that drivers clearly understand what it can and cannot do. This is particularly challenging because even small design changes can violate drivers' expectations and confuse them. In this way, automated cars are like paper towel dispensers: using a manual paper towel dispenser is not confusing. You grab and pull. Automatic and semi-automatic paper towel dispensers can be confusing. Some use motion—are motion sensitive and automatically roll out a towel when you wave a hand in front. Others require that you press a button to trigger a motor. Fruitlessly waving at a dispenser before you realize that it requires a button press can be embarrassing. Such confusion in a car can be deadly.

Like paper towel dispensers, push button ignition systems can be confusing. When the car is stopped, you only need to push the button to turn off the engine, but when in motion, you must press and hold the button. The need to press and hold can confuse drivers and could have tragic consequences when the driver tried to stop an unintentionally accelerating vehicle. Such mode confusion represents an important challenge for increasingly automated vehicles.

One benefit is that technology may counterbalance the threat of distractions. Distraction represents a longstanding safety problem that the explosion of entertainment systems threaten to exacerbate. Fortunately, other emerging technologies can detect distraction and direct drivers' attention to hazards. Soon cars will be able to know when you look away from the road, when the car had brakes, and when to call your attention back to the road. Over time, the car can even help you appreciate and avoid risks on the road.

The road ahead. As an engineer, I am very optimistic about the future of vehicle technology. As a researcher focused on the psychology of human technology interaction, I see substantial challenges. I hesitate to offer recommendations, and so I draw upon the wisdom of the Committee on Electric Vehicle Controls and Unintended Acceleration. I paraphrase several of their recommendations.

First, assess whether electronic interfaces, such as push button ignition systems, delay responses in emergency situations. Second, promote government and industry collaboration to create designs that communicate vehicle capability and status to drivers. Third, identify when drivers' expectations of vehicle automation diverge from designers' intent. And finally, establish electronic data recorders and associated information infrastructure to catch design errors that will escape even the most thorough design process.

Thank you.

[The prepared statement of Dr. Lee follows:]

PREPARED STATEMENT OF DR. JOHN D. LEE, EMERSON ELECTRIC QUALITY AND PRODUCTIVITY PROFESSOR, DEPARTMENT OF INDUSTRIAL AND SYSTEMS ENGINEERING, UNIVERSITY OF WISCONSIN-MADISON

1. *Driving safety is an important health problem.* Approximately 34,000 Americans died in motor vehicle crashes last year. These crashes are the most likely cause of death for those between 4 and 34 years of age, and account for 30 percent of teen deaths. The coming years will bring increasingly complex distractions and increasingly complex vehicles to drivers who may be unprepared for either. This technology can dramatically improve or degrade driving safety.

2. *Your car is a computer.* A typical luxury car requires over 100 million lines of computer code. Software and electronics account for 40 percent of the car's cost and 50 percent of warranty claims. We think of cars as mechanical systems, but they are actually rolling computers.

These computers are changing what it means to drive. They already enable cars to take over many important driving operations, with features such as adaptive cruise control, automatic parking, and autonomous braking. Entertainment systems now enable drivers to connect to social networks, hear text messages, and choose from thousands of songs.

From these changes a critical safety threat may emerge: with technology automating driving much of the time, drivers have the freedom to focus on the entertainment system, but the vehicle can then unexpectedly hand control back to the distracted driver. Drivers are particularly error prone in such situations. Changing vehicle technology may make such unexpected handoffs more likely.

Moore's law suggests the capacity of automation and entertainment systems will change rapidly, doubling every 18 months. This exponential increase means that in fifteen years we are likely to be discussing whether people should be *allowed* to drive—because autonomous vehicles may be much less error prone than people. Until cars assume complete responsibility for driving, the critical challenge is to design vehicles so that drivers clearly understand how the car works and what it can and can't do. This is particularly challenging because even small design changes can violate drivers' expectations and confuse them.

3. *Automated cars are like paper towel dispensers.* Using a manual paper towel dispenser isn't confusing: you grab and pull. Automatic and semi-automatic dispensers can be confusing. Some are motion sensitive and automatically roll out a towel when you wave a hand in front; others require that you press a button to trigger the motor. Fruitlessly waving at a dispenser before you realize you need to press the button can be embarrassing. Such confusion in a car can be deadly.

Like paper towel dispensers, push button ignition systems can be confusing. When the car is stopped you only need to push the button to turn off the engine, but when in motion, you must press and hold the button. The need to press and hold can confuse drivers, which can have tragic consequences when a driver tries to stop an unintentionally accelerating vehicle. Such mode confusion represents an important challenge for increasingly automated vehicles.

4. Technology may be particularly problematic for teen drivers. Vehicle technology may confront teen drivers with a "perfect storm" of challenges. New entertainment systems encourage multitasking. Teens are notorious multitaskers, which would *seem* to make them more able to handle distractions. But that's only what they think. The opposite is actually true: heavy multitaskers are more distractible. Teens are also less able to anticipate roadway hazards, and so are unlikely to anticipate limits of vehicle automation. The combination of increasingly distracted and distractible drivers managing imperfect vehicle automation may severely undermine driving safety.

5. Technology may counterbalance the threat of distractions. Distraction represents a long-standing safety problem that the explosion of entertainment systems threatens to exacerbate. Fortunately, other emerging technologies can detect distraction and direct drivers' attention to hazards. Soon cars will know when you look away from the road, when the car ahead brakes, and when to call your attention back to the road.

6. The road ahead. As an engineer, I am very optimistic about future vehicle technology. As a researcher focused on the psychology of human-technology interaction, I see substantial challenges.

I hesitate to offer recommendations, and so I draw upon the wisdom of the Committee on Electronic Vehicle Controls and Unintended Acceleration. I paraphrase several of their recommendations:

1. Assess whether electronic interfaces, such as push-button ignition systems, delay responses in emergency situations.
2. Promote government and industry collaboration to create designs that communicate vehicle capability and status to drivers.
3. Identify when drivers' expectations of vehicle automation diverge from designers' intents.
4. Establish electronic data recorders and associated information infrastructure to catch design errors that will escape even the most thorough design process.

The CHAIRMAN. Thank you. Senator Johnson, you have been sitting there deep in thought and reading. And, therefore, I think it is important that you ask questions.

Senator JOHNSON. I am up for it, thanks.

Tell me how this technology is going to roll out. I mean, we obviously have got to do some infrastructure building. Everybody—this is not going to be one car, you know. I mean, the whole fleet. Can somebody just describe, A, the total cost just of infrastructure building?

Mr. BAINWOL. That is a profoundly tough question. Even defining what this is, I think, is tricky. I think maybe a simple way to break this down begins to introduce the complexity and the evolution that we are about to go through.

So in today's world, if a driver needs to brake, he makes or she makes a choice to apply the brake. With assisted—with driver assists that are in the market right now, if the driver does not react in time, he may get a warning, and that is fairly prevalent.

Senator JOHNSON. I have got that.

Mr. BAINWOL. So you have got that. And then the next way, which is also in the market, is that if you do not react in time, the car will actively engage for you. The next step really is when big data goes beyond what the car can see. So, so far we have been operating with what the driver can see and what the car can see with its suite of sensors.

Connectivity really is about seeing what we cannot see and having every car within a mile radius or so benefiting from the probability of a challenge. They are all informed. Big data informs everybody, distills it in some fashion so that it is actionable. And I think as Administrator Strickland indicated, getting to a point where we have a connected fleet is a very long time away. The average age of the car is 11 years old. It is going to take forever to get to a point where this is—has permeated the mainstream.

But the value of it is enormous, and unlike a situation like ESC, or automatic braking, or automatic high beams where car makers innovate and then government responds and decides at some point that perhaps it should permeate the fleet, the connected space is a joint initiative where it does not go anywhere unless government and the private sector come together to make it a reality.

So the time and the money is a function of how much you are willing to spend and when you are willing to spend it.

Senator JOHNSON. Let us back up. I have got a Ford Taurus. I have had it brake for me. What about lane departure warning? How does that one work? I mean, what is it keying on? What is the sensor doing?

Mr. OWENS. I hope you like your Ford Taurus because we have some product in there that is hopefully helping you.

[Laughter.]

Senator JOHNSON. I do like it. I have got two of them.

Mr. OWENS. Good. Lane departure warning is—the usual implementation of that is looking at the lane boundaries with a vision system and determining when you cross or you are about to cross the boundary. And then the OEM, the automobile manufacturer, will typically decide what to do with that information. It can give you an alert. It can send an audible. It can shake your seat.

Senator JOHNSON. OK. So what it is looking at, paint? Is it looking at reflectors?

Mr. OWENS. All that. With today's digital signal processors being as fast and as affordable as they are, it will—even if you do not have painted boundaries, it will define a lane boundary for you and let you know when you are approaching that at a speed you should not be.

Senator JOHNSON. Professor, I live in Wisconsin, and some of those sensors, they break down. I mean, we get snow and slush. So where does that system break down? What are the problems with that?

Mr. OWENS. Well, a vision system will have problems in a heavy snow or heavy wet rain environment. The radar sensors like you have on your Ford Taurus sees through that. That is almost weather independent. So there are a variety of vulnerabilities to the technology, but radar operates in virtually any environment. The vision systems you can operate in most environments. Even on a snow packed road you can define lane boundaries.

Senator JOHNSON. So are you thinking it is going to be pretty minimal in terms of actual highway infrastructure spending on this? It is all going to be pretty much sensor with the vehicles?

Mr. OWENS. I mean, there are many paths to get there. An infrastructure-based system would be—is the compelling argument to get you all the information that you could possibly have to ensure a safe ride. You can do the individual car implementation as you have and get a lot of the way there without have any kind of infrastructure dependency.

So you would have an individual machine that could operate with a higher degree of safety, less fatalities on the road today for sure.

Senator JOHNSON. Dr. Sweatman, you raised your hand there.

Dr. SWEATMAN. Yes, thank you, Senator. I think your question was getting at the infrastructure cost side of it as well. And so, we need to be very strategic about that. Clearly there could be a large cost if we deploy throughout the infrastructure. So we must target—think about intersections, which is our main safety problem. If we were able to come up with a system where traffic control cabinets, which have to be there, were actually fitted with this wireless communication, we start to see a much lower cost solution. So we need a very strategic approach with the infrastructure.

On the vehicle side, the vehicle as we talked about can do a lot by itself. And also it was originally conceived as being a low-cost solution. So the wireless communication itself is affordable. It is really the infrastructure where the cost issue comes in. And we think we can be very strategic about how we roll it out.

Senator JOHNSON. Dr. Lee, would you like to add something?

Dr. LEE. Yes. I would like just to add a quick point, and that is the time constant and the development in these different industries. If you take the iPhone for instance, the original iPhone was just declared vintage. What is the age of a vintage car, maybe 60 years? So the difference between the fleet turnover in the automotive sector and the fleet turnover in the cell phone sector is dramatically different. And what I see because of that is the influx of distractions may be overwhelming the ability of the manufacturers

to create vehicles that can counteract some of those effects and maintain safety.

Senator JOHNSON. But just real quick, if I may, Mr. Chairman——

The CHAIRMAN. Senator Johnson, you are on a roll, sir. You take all the time you want.

[Laughter.]

Senator JOHNSON. The strategic nature of the rollout I think is key to this because what you want to do is—again, if you have infrastructure in place, you can add the cost in a low cost fashion. Then you can start taking advantage of the opportunities and test it where you are not overloading the system. So is that pretty much how you see—rather than all of a sudden trying to put something down every strip of every highway, which would be incredibly expensive, as well as go obsolete potentially when new technologies come on board.

Is that how people are thinking this thing through? And is government not going to interfere? That would be my biggest problem. And let me ask that question as long as the Senator is giving me leeway. What concerns you about government interference potentially in that strategic rollout?

Dr. SWEATMAN. Well, I think the rollout of the infrastructure obviously has got to be local. We have to lay that out throughout the country. So we need the capability to incorporate it at the lowest cost possible with systems that are already being deployed.

I think the industries that are producing the traffic control signals, the intelligent transportation industries, are very aware of this. And I think we will be very ingenious in the way we can incorporate it. You know, we can even tag black spots. We know where the crash black spots are in every state, in every city. So we can do some targeting.

Senator JOHNSON. OK. Again, so what I am looking for is who is talking to who, who has to talk—you know, which entities have to talk to each other. And, again, what concerns you about government's involvement? I am always concerned about government involvement.

Mr. OWENS. Well, I would offer—certainly the subject of vehicle-to-vehicle is going to be infrastructure dependent, and as fast as we can cooperate on the standards and get that unified amongst the industry, I mean, that will be a pacing item for that.

On the driver assistance systems, the product like you're experiencing there, the collision imminent braking, the lane departure warning, I think the key, as I mentioned, is to make that visible to the consumer, that it is available, that it is there. That worked extremely well for the airbag rollout. That worked extremely well for stability control.

Where the consumer saw that, saw the value of safety and brought that into the market faster than regulation required it, I think we have the same opportunity here. Let the market work. Let the market create the higher launch. Make people aware as you are. I would hope with your experience, certainly mine, I will never have my wife or my kids in anything other than an active safety-equipped vehicle if I have a choice, but only if I know it is

there on the vehicle, and I know what it does. You have to experience it to get the value of the technology.

So I think we can let the market work, and I think the—I think NHTSA and the NCAP system is a key ingredient to doing that.

Senator JOHNSON. We do need to be always be mindful of the cost. I mean, I can afford the upgrade. Not everybody can. And you have to be very careful in terms of cost-benefit calculation on that as well.

Mr. BAINWOL. But there two different activities here. One is the driver assist which will be market driven, and the costs will come down over time, and there the individual makes the choice. When you get to the connected car, it is a different animal. That is where government has to get involved, and there are two responsibilities. One is to make sure the spectrum works because you cannot have metal flying down the street at 100 feet a second and have the communications go faulty. And the second part of that is infrastructure. And because it is government funded, the rollout will in large part be dictated by government.

So, two different paths. They connect in terms of convergence.

Senator JOHNSON. That one I am skeptical of.

[Laughter.]

Senator JOHNSON. Thank you, Mr. Chairman.

The CHAIRMAN. I am very sad.

Senator JOHNSON. I am kind of an old dog.

The CHAIRMAN. No, I love it. I love it. Your questions were great.

Let me just ask a couple. We had a whole series of hearings in the last several years having to do with television, and, you know, what I call the rapid descension of content. And so the question was, it was not just, you know, violence, but also unhealthy things that kids were seeing or watchers were seeing.

But then we turned with great satisfaction to the ability of the parent to monitor what was going on and to be able to use the controls at that time available and now available to allow their children not to see what they should not see. Now, I think that is reasonable because just basic television today has—obviously the later in the night. But, I mean, there is some really bad stuff on it. And it has consequences.

But that is not my point. My point is, I do not think we ever really got a sense of confidence that the average parent, whoever that would be, throughout the country knew how to work the—you know, the promoter, I mean, the little machine that would set parameters. And if you cannot have that, then everything else fails.

Now, just moving to what we are talking about, I will make a terrible confession, and since my colleagues have basically disappeared, C–SPAN has not, so I am in some trouble but I've got a new, much gadgetized car because I am large, and the car is large, and it is a very happy coincidence. But we have just come out of winter, and I discovered that the air conditioning just did not seem to work. And I did what I remembered from previous iterations of automobiles, what would happen to make the air conditioning work.

Well, I had befallen to—I think the classic American tradition of failing to read the manual. And I think Americans will go to almost any length to avoid manuals, including, you know, diet and all the

rest of it. I mean, we are just wonderful at avoiding things that we ought to read. And then I discovered to my incredible embarrassment there was this little white button fairly low on the panel that was meant to look like a snowflake, I guess, therefore, implying cool. I had no—that was not a judgment I made, but I was told to push it. I pushed it, and all of a sudden the air conditioning came on.

Now, I think that is a very sad American story of which I am the villain. But I just raise the question of how sophisticated are people growing in technology in automobiles as they have to get it in and get to work or get to some—the dentist or whatever it is. And several people use the car, so who really reads the manual? Are manuals read? Are manuals read? I think there are substantial portions of that car that I still cannot work, but I do not need to. Well, now we are coming to a point where I may need to, you know, if over the next 10 years a variety of things, as you indicated, happen.

So I want to put that question to you. How reliable do you think drivers are these days in understanding some of the new electronics? Whoever.

Dr. SWEATMAN. Mr. Chairman, in Ann Arbor where we are testing 3,000 connected vehicles and the Secretary of Transportation said, you are testing these with ordinary Michiganders. And in many cases, they are parents in the public school system driving their kids to school and so on.

And so we have been running this for more than six months now, and we have regular contact. And there are no buttons on the connected vehicle system. So they are only getting information, and, in some cases, warnings, when the need arises. We are finding that the reaction from our ordinary Michiganders is incredibly positive. They thank us for the systems that we have deployed. And we have not come across any of those kinds of issues to do with confusion about the technology.

With connected vehicles, there is a lot going on in the background, but in the foreground, relatively little because these safety problems only occur infrequently.

The CHAIRMAN. Well, that is an extraordinary statement, and I have to accept it listening to it from you. But any comments further?

Mr. BAINWOL. Mr. Chairman, I have a confession to make, too. [Laughter.]

Mr. BAINWOL. I cannot operate my TV very well, and my kids make fun of me. But when I get in the car, I found that the driver-assist technologies are really intuitive, and I think that is the trick.

One of the reasons why Apple is so successful is that everything is very intuitive. And when you get in the car in today's world, even the guy who cannot operate the TV and program it to record a show later on can get in the car, drive it, and benefit from driver assist because it really is incredibly simple, and it basically does it for you. So if I am driving down the highway—and this happens every morning—if I put my blinker on to go to the left, my blind spot warning will notify me and just chimes. It is there for me, and it says there is something in the way, do not go. And I do not have to do anything. I just know it.

If I am going too fast it will alert me that the distance between the car and my car—the car in front of me and my car is too close for the speed I am going, and it will chime, and it basically says wake up and be careful. If I set it on adaptive cruise control, it manages that distance precisely.

So that is the trick. The engineering function and challenge is to make it intuitive. People ought to be responsible and read the manuals, but when they do not, the system should work. And, in fact, these technologies are doing that.

The CHAIRMAN. You referred to the technology, which means the ability to drive the car if you slip over into another lane to be forewarned about that. And I look forward to that very, very much. What about that part which is entertainment?

Mr. BAINWOL. The information in the car has an upside and a downside. The upside ultimately plays out in the context of connectivity and big data warning the car and all the car's systems that there is a potential challenge. The challenge with information is managing it in the car. And the discussion I thought with Administrator Strickland was very instructive, but I think it missed a bit of the point, if I can take a minute here.

There are 5.5 million crashes in this country pretty much every year. Seventeen percent of those are distraction related. That is about a million of those. Two percent of those happen as a consequence of using the internal built-in integrated system of the car. That is 2 percent of the five and a half million crashes. I am sorry, 2 percent of the million.

Ninety-eight percent are a function of distraction from some other cause. The guidelines that NHTSA issued deal with the 2-percent, but do not touch the 98 percent. So I think what the administrator did today was really important in talking about the stakeholder briefing, the stakeholder's meeting, where he would bring together or propose bringing together manufacturers, software folks, OEMs, social media companies, to deal with the issue of how you manage information in the car, because the guidelines deal with two percent, not 98 percent. And if we are serious about dealing with distraction in this country, we have got to focus where the real battle lies.

The CHAIRMAN. I totally agree. Dr. Lee?

Dr. LEE. Yes. I would like to go back to your original question and take a bit of a different perspective than some of the optimistic panelists here.

I think your experience is more common than not. I think there is great potential for confusion with these new systems. I saw an article just the other day discussing a new vehicle that came out and had a larger expanded glove box the author is arguing to accommodate the user's manual that was so large.

These cars are incredibly complicated, and there is some good data that suggests that drivers do not always understand what these systems do—adaptive cruise control, for example. People think it has capabilities that it may not actually have.

Another example, I think of that, goes back to my towel dispenser. Such a simple thing. You put a little computer behind it, and now it becomes mysterious. And we have got a car with 70 to 100 interconnected computers. That is incredibly complicated and,

in some cases, quite mysterious. For my vehicle, for example, there are 165 different parameters that I can adjust, all keyed to my key fob, so I get into the car, and the car is a different care for me. My wife gets in, and 165 parameters change, and it is a different car for her. What happens if I grab her key fob? Now, I am driving her car, which might be quite different than my car. Those sorts of confusions, I think, are new and did not exist before the car became a computer.

One more example. Going back to the confusion with the on/off switch. In the past, starting your car, stopping your car, you did it with a key. You turned the key off and pulled it out. You could not pull it out before the car was turned off. With these key fobs, you can take your key fob, get out of the car, close the door, walk away, and it is still running. And this has actually happened, and poisoned with carbon monoxide the occupants of the house after they left the car in the garage running.

The CHAIRMAN. Interesting.

Dr. LEE. So I think there is confusion. There is new potential for error. I do not want to be too negative because I think there is huge potential for enhanced safety, but there is a negative side, and we have to acknowledge that.

The CHAIRMAN. I will take both of your answers, but first I want to ask another question. I am not sure to which extent—well, my final question is going to be, what do you think the role of NHTSA ought to be. I want each of you to answer that.

But I am not sure of the swiftness of the younger generation, whatever that means, declining to buy automobiles because of the cost, and the economy, and efficiencies. You know, driving in Washington almost any time of day makes you want to take Amtrak right down 16th Street——

[Laughter.]

The CHAIRMAN.—and just bowl over everything in sight. I mean, it is so frustrating. And now—and then that makes sense because then you have to get big buses because you can put a lot more people on big buses and, therefore, take a lot of cars off the road. But those buses cannot make turns without holding up traffic for 10 or 15 minutes as they try to wiggle a turn. In other words, it is all very, very complicated.

America is in love with automobiles. That will never cease. I am in love with automobiles. That will never cease. However, I do not want to die. I am not technologically gifted, as the staff behind me can very well tell you. But I am very serious about my work, and that is why I come back to the mission of NHTSA, that this hearing is one about what the car of the future is going to be like. And actually I get the impression from several of you that the car that is coming about is not going to come about for another maybe five or 10 years, that we are not talking quite as quickly as we think we are, but I am not sure that is correct.

So the role of plain safety of when you put your hands on a steering wheel and it reads your blood alcohol content, the saving of—I come from a coal state, but, you know, so what? I mean, I think that it is very important to really crack down on carbon monoxide, and I do not think this country will survive unless we find a way

to take 90 percent of the carbon dioxide out of coal, which we have found, but declined to use or fund. So those are problems.

So to me, basic safety is important. I love—one of the reasons I really like my new car—it is 3 years old—is because it is big, and it is really fun, OK? But when I get down to it, the—what I really want to do is just drive, and I want to listen to my music. I mean, one, it calms me down when I go to work, and it calms me down when I come back from work. And I like driving. I like driving a lot. So I am not really into the gadgets, but then again, I am of another generation.

So let me just simply say, what do you think the role of NHTSA ought to be? Please.

Mr. OWENS. That is the $64,000 question, right? I mean, that is what we are talking about. So, you know, the industry—the automobile manufacturers and suppliers, we are going to work very hard to take what is already the most complicated piece of electronics you own—your car—and work to make it simpler, work to make it more intuitive, work to make it more seamless.

But just as you have your desires, the 25-year-olds and below have their desires, and they want to interface with that vehicle in an entirely different way. And yet the product has to service all of those demographics, and that really is our challenge—to provide the technology that is less distracting, that keeps the driver in the loop, and keeps the driver safer tomorrow than he or she is today.

There is a lot of media coverage about autonomous vehicles today and driverless vehicles, and I think that may happen at some point in the far future. But for a lot less money and a lot quicker application—and I am not talking 10 years. Active safety technology can be applied today and have significant benefit to the statistics of both accidents and fatalities in the United States. The technology is mature.

I think NHTSA would recognize it as mature enough to consider that, and I really do think letting the market work here, no mandate required, no regulation required, just let the—let it be visible to the consumers now, immediately, and you will see the market forces start to self-select because safety does sell.

We have a lot of other things to work on. There is no doubt about it. And we are dedicated to solving those problems. But we can get a lot of the benefit of an autonomous vehicle today in a semi-autonomous mode in a couple of years if we have the fortitude to stay with it.

The CHAIRMAN. Would you—if it were a financial body, would you have applied NHTSA to Wall Street in recent years?

Mr. OWENS. I am sorry. Could you repeat?

The CHAIRMAN. Would you apply—if NHTSA were a financial body to Wall Street in recent years? In other words, the idea to let the market work, and, oh, yes, you are going to get all those hundreds of billions of dollars, and you can spend it on mortgages and low income housing or whatever, and none of it got—and not one dime got spent. I mean, people just line their pockets, and making no comparison between that and automobiles.

But, you know, I just—I worry about that. I worry about safety. I do not want people to die. We have really twisted roads in West Virginia, and actually so do a lot of—most rural states. Interstates

are more rare. So I am just trying to find something besides let the market work. When I hear "let the market work," I start thinking about coal mines and, you know, all kinds of things, and I get very uncomfortable.

Mr. BAINWOL. Can I add to this? We are saying let the market work in one sense, but it is different than the Wall Street context.

The CHAIRMAN. Good.

Mr. BAINWOL. What we are really saying here is the marketplace for all sorts of reasons, for reasons of commitment to safety, for reasons that safety sells, for reasons of liability, is producing today driver assist technologies that will deal with the accident rate in West Virginia. We are on the precipice of a golden age in safety. The news is good news. The longer term question is when we get to the connected car.

Now, the role of NHTSA, the role of NHTSA is to do exactly what they do. It is a relatively small agency of really grounded, committed public servants who focus through data on safety issues. We work very closely with them and in an appropriate way. There is no hide the ball. We share technologies. We do many studies together.

The exercise on the connected car is a joint effort of suppliers, OEMs, and NHTSA. That is a very proper role about defining a brighter future for safety. Same thing with that in terms of drunk driving.

So NHTSA engages with the industry properly. We engage with NHTSA. But NHTSA also has regulatory authority and it has a hammer, which has been used. And at times that is appropriate. So we have the right relationship. It is, we hope, data driven. And I think we are on course to a great outcome. This is a good news hearing. The future promises really massive gains in safety if we make the right public policy choices, especially on the spectrum issue.

The CHAIRMAN. Yes, which actually brings us—in other words, we have congressional oversight. I am also on the Intelligence Committee, and we are meant to have congressional oversight of intelligence. And let me tell you, that has been about the most impossible job because government does not want to turn anything over. They all want to protect themselves. And I do not think car companies are necessarily that way, and, in fact, when we had the so-called sudden unintended stop crisis, you remember, with Toyota and other companies, the work was quite good I thought. The result was good. People changed habits. The culture of safety of a different sort was developed. And, you know, I not unoptimistic about the automobile industry. I just want to be certain. And I have kept you all too long.

Dr. Lee, you look like you need to say something.

[Laughter.]

Dr. LEE. I do not know whether I need to say it, but I will. I come from a different perspective, so weigh that accordingly. And you may want to discount it entirely.

I think one of the things that we see in the automotive industry is a dramatic change, a really dramatic change. Because computers underlie things, change is occurring at an exponential rate. And we project—as people we project change linearly, so we are thinking

in 10 years these smart cars will be 10 times better, maybe 15 years 10 times better. But, in fact, in 15 years, they will be 1,000 times better, dramatic, qualitatively different than we might expect.

So I think change is happening extremely quickly, and this is a very different environment than NHTSA grew up in where cars turned over every 6 years. Now you are working a computer industry where models are turning over every six months, so 10 times difference.

I think the vehicle and the car and how people treat cars is also changing dramatically. I think the generation that grew up with Bruce Springsteen, and the romance of the road, and using the cars as a way to get away from the parents, that is changing. Kids get away from their parents with their phones, with texting. Cars are a distraction to them. And so I think they may be shifting their patterns in a way that is also surprising.

So the role of NHTSA in this new environment—I think there is an important role, and I hesitate to offer any strong recommendation. But from the report regarding the Toyota unintended acceleration events that occurred years ago, from the National Academies, one of the things that came out of that I thought was really interesting, and that is that the vehicle environment is changing qualitatively, as I mentioned, and, therefore, the regulatory environment may need to change accordingly.

And they suggested looking at other agencies, like the FAA, or the FDA, as models for how NHTSA may want to adapt to this new environment. So I think there may need to be a qualitative shift in the nature of what NHTSA does, its business.

And I think one sort of concrete example that came out of that that I thought was very good, and that is in medical products. The FDA has a system that provides feedback when there is an unintended event, a misuse, or an inadvertent use, or a malfunction in a medical product gets fed back to the agency and then to the industry to enhance reliability. And I think that that sort of mechanism is necessary.

So in the future, when cars become smarter, more capable, they will do things for the driver. They will surprise the driver. And increasingly, drivers will blame the car for doing something crazy. And that blame, as we saw with the Toyota events, is difficult for NHTSA and the industry to understand.

There was a long period of failing to understand what was underlying those events. That is injurious to the government, it is injurious to the manufacturers, and it is worrying to the consumers. And so I think what we need is a better information infrastructure to help NHTSA identify and understand the inevitable failures that will come out of these computerized vehicles.

The CHAIRMAN. All right. I want to end the hearing. If you have got something to say, it has got to be so incredibly good.

[Laughter.]

Dr. SWEATMAN. No problem.

The CHAIRMAN. All right.

[Laughter.]

Dr. SWEATMAN. I think NHTSA has an incredibly important role because transportation has become a team sport. So there is a con-

vening as well as a regulatory role. And one of the very important issues that is going to need convening is liability and responsibility for crashes because we are going to continue to have crashes for a very long time.

Is that shifting in some way? We have always said that is the driver's responsibility. Is there some shift there? So I think that kind of question is something that NHTSA really needs to convene and make some policy guidance on as we move forward because that will become a very important issue.

I hope I lived up to your expectation.

[Laughter.]

The CHAIRMAN. You did. You did, in fact. In fact, you all did. And I do not see a whole lot of people sitting at this dais, but that does not matter. It is a hearing. Everything is recorded and written down, and I think some very interesting and good ideas came out of all of this. And you were all very good witnesses.

So, having said that, I do not like to bang a gavel. It looks superficial to me. So I will just declare the hearing adjourned. And thank you.

Mr. BAINWOL. Thank you.

Dr. LEE. Thank you.

[Whereupon, at 4:26 p.m., the hearing was adjourned.]

A P P E N D I X

PREPARED STATEMENT OF HON. FRANK R. LAUTENBERG,
U.S. SENATOR FROM NEW JERSEY

Mr. Chairman,

As a long-time leader in the fight to save lives on our nation's roads, I believe it is critical that we utilize technologies to make sure that Americans can safely get where they need to go. Road deaths were up more than five percent in 2012, and drunk driving in America takes a life every 53 minutes. We must use the technologies available now that we know save lives, such as ignition interlocks to prevent deaths from drunk driving. We shouldn't wait to deploy them. And, as we look to the future, there are a number of exciting, new technologies being developed that have the potential to transform the way we drive and make our roads much safer.

Drunk driving continues to take thousands of American lives every year—9,878 in 2011 to be exact. Nearly a third of all vehicle deaths involve alcohol. And studies show that 50 to 75 percent of drunk drivers whose licenses are suspended continue to get behind the wheel. The bottom line is there is a clear need to do more to stop drunk driving, especially to keep repeat offenders off the road, and we have the technology available to do just that.

Ignition interlock systems can prevent drunk driving and save lives, yet they are used sparingly. That's why I plan on re-introducing my common-sense bill to require convicted drunk drivers to install ignition interlocks in their cars. These devices do not let a vehicle start if the driver is drunk—and they are proven to work. In fact, a Centers for Disease Control and Prevention study found that re-arrests of convicted drunk drivers dropped 67 percent when ignition interlocks were installed in their cars. It's no wonder then that the National Transportation Safety Board has recommended just what my legislation proposes. We should move on my bill immediately so we can save the lives of more drivers, passengers, and pedestrians.

There are other technological innovations and resources currently available that can increase safety on the roads. Speed limiters can make our highways safer by keeping trucks at safe speeds. As we know, driving slower can help motorists avoid collisions. And when paired with Electronic On-Board Recorders, which I mandated for all commercial truck drivers in the 2012 surface transportation law, we can ensure that truck drivers who are fresh and rested don't then drive at dangerously faster speeds to cover more miles within their time limit. And lastly, helmets—which are simple but important safety tools—can help halt skyrocketing motorcycle fatality rates. In 2012, motorcycle fatality rates increased by 14.7 percent—the largest increase ever. Head injury is the leading cause of death in motorcycle crashes—and helmets don't need to be a fancy, expensive new technology to be an effective safety tool. So we must move forward on motorcycle helmet requirements. It would be a simple, reasonable step that would slow the repeated and growing number of tragedies on our roadways.

Technological achievements like ignition interlocks and speed limiters show us why it is critical for us to continue to look for new technologies that have the potential to further improve safety in the future. New driver assist systems are being developed, for example, that can automatically brake a car and control steering to avoid collisions—saving drivers from serious accidents and the more minor, but often expensive, fender bender. Driverless cars—which I had the opportunity to experience last year—could reduce human error by monitoring and automatically responding to roadway conditions, a change with the potential to save thousands of lives. And vehicle-to-vehicle communications are being tested that would allow cars to talk to each other and coordinate movements that could, if deployed system-wide, potentially reduce up to 80 percent of crashes involving non-impaired drivers.

The technologies of tomorrow hold the potential of revolutionizing driving to make today's roadway catastrophes a thing of the past. And if we effectively deploy the tools we have now, we won't have to wait to realize safety gains.

I thank the Chairman for calling this hearing to offer a glimpse of how technological innovations can create safer roadways in the future. And I thank our witnesses for offering their expertise on these incredible advances.

PREPARED STATEMENT OF ISAAC LITMAN, CEO, MOBILEYE AFTERMARKET

Chairman Rockefeller and Senator Thune, and all the members of this Committee, thank you for this opportunity.

I don't have to tell about the 5 million yearly vehicle crashes in the U.S. with annual deaths of well over 30,000—34,000 in 2012—and with over 2 million injured persons a year. And that 20 percent of the traffic injuries involved reports of distracted driving.

A growing concern is the rising numbers of pedestrians and bicycle riders killed or injured. Rear-end collisions account for just under half of all crashes and unintended lane departure is the major cause of fatal crashes. Among all fatal crashes in 2009, 16,265 were caused by lane departure. The National Highway Transportation Safety Administration notes that the Human Factor is the cause of over 90 percent of crashes.

The National Transportation Safety Board's "Ten Most Wanted" solutions for 2013 included collision avoidance technologies for lane departure and forward collisions, and addressing distracted driving issues. The Federal Motor Carrier Safety Administration has similar concerns—including bus accidents with pedestrians; a growing problem in urban areas. It noted in its recent report on "Benefit-Cost Analysis of Onboard Safety Systems" the benefits of collision avoidance technology on buses.

A growing proportion of new cars have electronics and computer systems which may permit drivers with various options to avoid accidents.

My company, Mobileye, with offices in New York, makes inexpensive, optical collision avoidance devices which have been adopted worldwide by vehicle manufacturers such as GM, Ford, Volvo, BMW, Honda, Hyundai, Nissan and many others. Other companies offer similar solutions based on various other technologies, so there are options for consumers and the Federal Government.

However, most of these options are only for consumers who buy new vehicles. According to the IIHS, with the normal "turn-over" rate, it will take 30 years to have these technologies in widespread use in the U.S. Mobileye has developed additional, inexpensive solutions that can be retrofitted into existing vehicles. The Mobileye Aftermarket solution is the same as the solution used by the OEMs but with the ability to retrofit. Mobileye Aftermarket meets the standards and qualifications set by NHTSA for these technologies: NHTSA Lane Departure Warning standard and NHTSA Forward Collision Warning Standard. Unlike airbags or ESC this Collision Avoidance System can be retrofitted on any car, truck, or bus; meaning that implementation of these technologies in the U.S. can be much faster; as it prevents many injuries and avoidable deaths.

The Mobileye vision-based collision avoidance system has multiple features: pedestrian collision warning, bicycles collision warning, unintended lane departure warning, vehicle collision warning, headway monitoring, following time violation, speed limit indication (the ability to read speed-limit signs and warn the driver of excessive speeding), and intelligent high-beam control. This single device is also very easy and quick to install in the aftermarket in cars, trucks, and buses.

Our technology, and the technology of other companies, has been tested and proven effective. One Mobileye-equipped U.S. fleet opted to share their data and reported a nearly 40 percent reduction in their incurred-incident cost per mile and an impressive 25 percent reduction in accidents since adopting Mobileye solutions, with well over one billion miles driven with the systems to date.

Imagine eliminating 25 to 40 percent of all vehicles accidents with inexpensive, aftermarket technology. It not only reduces deaths, injuries, and the use of judicial and police resources; it will eliminate thousands of "routine" crashes that create traffic jams.

So for $900 or so, trucks, buses, and cars can be equipped with devices that prevent accidents with pedestrians, bike riders, and other vehicles, and stationary objects. Affordability and ease of installation in the aftermarket are both very important since many collision avoidance systems can cost over $10,000 and Americans only replace about 6 percent of our cars each year (the average car is over 10 years old). Thus, affordability and ease of installation is very important to the typical American family. One study estimates that the total annual cost of road crashes in the U.S. is over $200 billion.

Why is this technology important to the Federal Government and the Congress? Think of the massive savings to federal fleets of vehicles because, unlike American

businesses and families, the Federal Government is not allowed to insure their vehicles. Depending on liability, taxpayers pay a lot of the costs of those medical injuries, deaths, and lost wages, and the damage to, or destruction of, federal vehicles.

Fortunately, the Comptroller General of the United States has been asked in a bipartisan request by Members of Congress to determine the savings to the Federal Government by installing these types of devices on federal vehicles. I assure you, those savings will be enormous. The Federal Government could save billions of dollars by simply having inexpensive, aftermarket collision avoidance devices installed on 10 to 20 percent of the federal vehicles, a year.

This is about more than saving billions of dollars for the Federal Government; collision avoidance systems save lives, prevent debilitating injuries, save families, and can reduce the number of incidents police and other emergency response teams have to address.

Mr. Chairman, thank you for this opportunity to testify.

RESPONSE TO WRITTEN QUESTIONS SUBMITTED BY HON. JOHN D. ROCKEFELLER IV TO HON. DAVID L. STRICKLAND

Question 1. As the vehicle becomes more reliant on electronics and electronic safety systems, NHTSA must be able to address the changing safety landscape. Moving Ahead for Progress in the 21st Century (MAP–21), which was enacted into law last year, directed NHTSA to establish a Council on Vehicle Electronics and Emerging Technologies and to conduct research into electronic safety systems. In response to my questions on this topic at the hearing, you stated that NHTSA has a solid game plan for a newly established Electronics Research Office, and you offered to provide additional detail for the record.

Question 1a. Please detail how NHTSA will fulfill the requirements of MAP–21 in this area, and how it is addressing the new safety challenges that will arise from the growth of vehicle electronics.

Answer. Increased use of electronic controls and connectivity is enhancing transportation safety and efficiency. However, these new technologies may result in new failure mechanisms and cyber vulnerabilities. NHTSA recognizes these new challenges and is addressing them through research, rulemaking, enforcement and data collection and analysis.

In the area of research, NHTSA created the Electronic Systems Safety Research Division in 2011 to address potential safety risks. We believe electronic control systems in vehicles raise concerns for driver safety in the areas of system reliability and cybersecurity and is conducting new research in these areas. The programs are closely related and intertwined. The agency believes that a motor vehicle cannot be safe if it is not secure. The overarching goal of both programs is to inform potential regulatory options.

The goal of the electronics reliability research is to enhance the functional safety of emerging safety-critical electronic control systems. In the near term, the reliability research program will seek to:

(1) Define and prioritize automotive electronic control system safety issues;

(2) Assess functional safety requirements;

(3) Evaluate the use of prognostics and diagnostics; and

(4) Identify fail-safe/fail operational mechanisms.

The goal of the cybersecurity research is to harden motor vehicles against potential cyber threats and vulnerabilities. The cybersecurity program seeks to:

(1) Identify the potential cyber threats and vulnerabilities;

(2) Conduct a security assessment;

(3) Develop a threat model and matrix; and

(4) Identify and evaluate potential solutions and countermeasures.

To coordinate and manage agency activities in the area of vehicle electronics, the agency has established, as required by MAP–21, a Council on Vehicle Electronics, Vehicle Software and Emerging Technologies. The Council meets on a bi-monthly basis to discuss and share information. The mission of the group is to broaden, leverage and expand the agency's expertise in motor vehicle electronics and to continue ensuring that these technologies enhance vehicle safety. Currently the Council is assessing the need for safety standards for vehicle electronics by overseeing a data analysis of the types and frequency of electronic control system failures. The results will be a key input to the report to Congress on the need for safety standards in the electronics area. We expect to deliver this report in 2014.

The Council has representatives from all of our vehicle safety offices including research, rulemaking, enforcement and data collection and analysis. Our Office of Enforcement continues to provide their technical expertise in the areas of electronics based upon their experience with compliance testing and defects analysis. Our Office of Rulemaking is evaluating existing safety standards and is ready to act when regulatory action is needed. The National Center for Statistics and Analysis is considering how to meet new data needs related to crash avoidance technologies and electronic control systems through its data modernization project. At the same time, all our vehicle safety offices are working towards strengthening their expertise in this important area.

Question 2. Since the enactment of the Highway Safety Act, the vehicle has become demonstrably safer, with both the number of deaths per year decreasing as well as the rate of deaths per hundred million vehicle miles traveled. Please provide some context to the role that NHTSA and its predecessor, the Transportation Safety Bureau, played in decreasing highway deaths.

Question 2a. Please describe the downward trend in highway deaths, the role of key safety mandates in accelerating this trend, and an approximation of the number of lives saved by each of these key mandates.

Answer. In 1966, 39,131 occupants of passenger vehicles (cars, pickup trucks, SUVs, and vans) died in crashes. That number increased to an all-time high of 42,117 in 1969. The number of passenger vehicle occupant fatalities dropped to 32,843 in 2002; and that number dropped to 21,253 in 2011.

In 1966, passenger vehicles were driven 856 billion miles; that number increased to 2,625 billion miles in 2002 and 2,646 billion miles in 2011.

The occupant fatality rate per 100 million vehicle miles of travel was 4.57 in 1966, 1.25 in 2002, and 0.80 in 2011. The fatality rate had dropped by 73 percent from 1966 to 2002 and by 82 percent from 1966 to 2011.

The Federal Motor Vehicle Safety Standards (FMVSS), mandated by the National Traffic and Motor Vehicle Safety Act of 1966, accounted for a large portion of the fatality reduction. A NHTSA evaluation published in 2004 estimated that the FMVSS saved 22,999 lives in 2002; an additional 1,562 were saved by voluntary safety improvements to the vehicles (not required by a FMVSS or implemented before the effective date of a FMVSS) This total of 24,561 lives saved corresponds to a 42 percent reduction in occupant fatality risk per mile of travel from 1966 to 2002 (a large portion of the overall 73 percent reduction). NHTSA is currently updating the evaluation through model year 2011.

The effectiveness of certain motor vehicle safety equipment addressed by FMVSS, such as seat belts, child restraint systems and motorcycle helmets, is dependent on their use by motorists. The following table illustrates the effectiveness of these devices at use rates achieved in recent years alongside estimates of lives saved by other safety advances.

	Lives Saved				
	Seat Belts	Frontal Air Bags	Child Restraints	Minimum Drinking Age Laws	Motorcycle Helmets
2011	11,949	2,204	263	533	1,617
2010	12,582	2,315	303	552	1,556
2009	12,763	2,387	307	626	1,486

Source: NCSA.

NHTSA's behavioral grant programs have also been a major contributor to improved national highway safety performance. A review of NHTSA grant programs conducted in 1998 found that "the Federal grant program has achieved the intent of Congress when it passed the Highway Safety Act of 1966. Federal grants which represent less than two percent of the funds expended on highway safety programs have led the states in addressing the most important safety issues and leveraged funds to provide many services to a wide public." "*Highway Safety Assessment: A summary of Findings in Ten States*" (DOT HS 808 796).

Question 3. Administrator Strickland, as you know, I am terribly concerned about the risks of distracted driving. I am becoming increasingly worried about these systems built right into the car. The touchscreens offer to keep drivers "connected" but are distracting to drivers who should be focused on the task at hand. At the hearing,

we discussed NHTSA's new guidelines to limit driver distraction from these systems.

Question 3a. Auto companies tell us that if the built-in systems are too restricted, drivers will just bypass those systems and pick up their phones. Do you agree?

Answer. The NHTSA Phase 1 Distraction Guidelines, published in April 2013, apply to original in-vehicle electronic device interfaces. The Guidelines recommend that visual-manual activities (i.e., those activities involving looking at a device interface and manipulating it with one's hand) that are not suitable for performance while driving should be locked out.

We are aware that some have expressed the opinion that by having our Phase 1 Guidelines only cover built-in devices, consumers would shift to the less-restricted (and possibly less safe) hand-held devices. We believe this opinion is based on the assumption that safer in-vehicle systems will not be sufficiently functional to attract drivers away from use of hand-held devices. On the contrary, vehicle manufacturers are rapidly expanding the voice-command and hands-free, eyes-free capabilities of their in-vehicle systems. These systems are engineered to encourage hand-held users to pair those devices with the vehicles' displays and controls. NHTSA sees no evidence that drivers would un-pair the devices from the vehicle system simply to obtain marginally increased functionality in very limited situations. As a result, the agency believes that there would be little incentive for a driver to revert to the hand-held device simply to perform a locked-out function such as texting. Therefore, should manufacturers choose to conform to the NHTSA Phase 1 Guidelines, the agency believes the more likely outcome is that drivers will pair their hand-held devices to the vehicle systems during all driving situations with a net benefit for safety.

We are currently developing our Phase 2 Distraction Guidelines, which will address visual-manual distractions for hand-held portable and aftermarket devices, and will soon begin discussions with the various portable and aftermarket device stakeholder groups and organizations. We are eager for their input as we develop guidelines for hand-held devices.

Question 3b. How can NHTSA best address distracted driving, and do you have all of the authority you need to do this vital work?

Answer. In April 2010, NHTSA published a "Driver Distraction Program Plan" that serves as the Department of Transportation's guiding framework in its efforts to eliminate crashes related to driver distraction. The plan lays out strategies for better understanding the distracted driving problem, minimizing the distraction potential from in-vehicle and portable devices, avoiding crashes that might be caused by distraction and improving driver behavior. Building upon this plan, in June 2012, NHTSA released a "Blueprint for Ending Distracted Driving" that describes the steps that NHTSA and the rest of the Department have taken to address distracted driving and the future steps we intend to take to eliminate crashes attributable to driver distraction.

NHTSA's efforts include raising public awareness, developing public policies on distraction, and conducting research and development. Regarding NHTSA's public policy work, the agency has engaged in efforts to minimize the potential for distraction from devices through Driver Distraction Guidelines. The Phase 1 Guidelines, published in April 2013, apply to original in-vehicle device interfaces and recommend that visual-manual activities not suitable for performance while driving should be locked out. In the area of research and development, NHTSA has conducted research analyzing driver distraction and its effect on driving performance. For example, the agency recently published a report analyzing data from a naturalistic driving study and examining the differences between hand-held, hands-free and integrated hands-free cell phone use.

NHTSA is currently developing its Phase 2 Guidelines, which will address visual-manual interfaces for hand-held portable devices and aftermarket devices not originally installed in vehicles, including aftermarket GPS navigation systems, smart phones, electronic tablets and pads, and other mobile communications devices. NHTSA also continues to conduct research related to driver distraction, including the effect of distraction on driving performance and whether advanced crash warning and driver monitoring technologies could help address crashes related to distraction.

In addition, the agency supports the enactment and enforcement of distracted driving laws. In the area of State enforcement, NHTSA is currently developing high-visibility enforcement programs for distracted driving laws. In 2011, the agency initiated pilot programs in Hartford, Connecticut, and Syracuse, New York, that promoted the message, "Phone in One Hand, Ticket in the Other." These programs showed that increased law enforcement efforts combined with targeted media can

lead to decreases in texting and hand-held cell phone use while driving. In 2012, the agency expanded the pilot program to Delaware and the Sacramento Valley of California. Also in 2012, NHTSA announced a new grant program authorized by MAP–21 to provide grants to states with conforming laws banning distracted driving.

Under NHTSA's existing authorities, the agency will address distracted driving by continuing to raise public awareness, including better educating young drivers, develop public policies on distraction, conduct research and development, and support State efforts to enact and enforce distracted driving laws.

Question 4. The vision of cars that drive themselves—safely maneuvering down the road while occupants busy themselves with other tasks—has certainly captured the imagination of many people in this country. If this vision comes to pass, it certainly will be a long ways off. Administrator Strickland, I want to give you the opportunity to think creatively about a future in which the driver is no longer essential for a vehicle to function.

Question 4a. How will truly autonomous cars change the American relationship to the car? How would auto companies and the government need to adjust?

Answer. Fully automated or self-driving vehicles could drastically change how Americans relate to their vehicles. A vehicle with full self-driving automation would need to be designed to perform all safety-critical driving functions and monitor roadway conditions for an entire trip. Such a design anticipates that the driver will provide destination or navigation input but is not expected to be available for control at any time during the trip. This concept could include both occupied and unoccupied vehicles. By design, safe operation rests solely on the automated vehicle system.

Motor vehicle automation can potentially improve highway safety by providing early detection of unsafe conditions, initiating precise vehicle control during normal driving and maintaining appropriate driver attention to traffic and roadway conditions. It is likely that in the near-term, automation in motor vehicles will involve a driving experience that transitions between automatic and manual control of the vehicle in complex and rapidly changing traffic conditions.

At the same time, vehicle manufacturers have begun or have announced plans to offer certain types of automated crash avoidance safety systems as features on new vehicles. NHTSA has been actively involved in researching these advanced technologies, which rely on in-vehicle sensors and cameras to obtain safety-critical data. For example, NHTSA is engaged in research to evaluate the effectiveness of currently available automated braking systems in avoiding or mitigating crashes. Also, NHTSA and other Department of Transportation agencies, in conjunction with the auto industry, have been conducting in-depth research and demonstration of vehicle-to-vehicle (V2V) communications technology, which offers substantial crash avoidance possibilities, particularly when linked to active in-vehicle crash avoidance systems. As part of this research, the agency is developing test procedures to evaluate these technologies and methods to assess their safety benefits. The results of this research may suggest novel techniques that differ from our traditional procedures and methodologies.

NHTSA believes that automation runs along a continuum, from vehicles with no active control systems to fully automated self-driving vehicles. While NHTSA is conducting research along the entire continuum, our initial emphasis is on determining whether crash avoidance and mitigation technologies that are currently or imminently available could provide safety benefits. For example, we expect to make agency decisions on automatic braking systems and V2V technology later this year. Because these same technologies may be the building blocks for what may one day lead to a self-driving vehicle, we have also begun research focused on safety principles that may apply to higher levels of automation. NHTSA's research approach will define the requirements for automation as a vehicle safety subsystem, which promotes safety by continuously optimizing vehicle and driver responses.

Question 4b. Are there changes that we need to start making in the near term to allow for progress in this area?

Answer. NHTSA recently issued a Preliminary Statement of Policy Concerning Automated Vehicles. We issued this statement to clarify relevant concepts, outline NHTSA's planned research on vehicle automation and help states implement this technology safely so that its full benefits can be realized. Articulating our views on these safety issues now is a very important element of charting that course, as confusion or disarray on the safety issues would be a significant impediment to the development of these technologies. Moreover, as several states step forward to become test beds for some of the most innovative automotive technologies, they, as well as companies seeking to develop the technologies, have asked NHTSA to provide rec-

ommendations on how to safely conduct such testing on public highways. Accordingly, while the larger dialogue with the many stakeholders progresses and takes further shape, the statement presented our views on the major safety issues related to the development of vehicle automation.

While NHTSA does not see any regulatory impediments to the introduction of automated vehicles at this time, we have initiated automated vehicle research to ensure that as automation is introduced into the marketplace, American drivers, passengers, and all those who share the roadways with them will remain safe. In the near term, our research program will focus on the following activities:

(1) Investigating human factor principles that are supportive of the driver and would help ensure a safe transition between an automated driving mode and manual driving;

(2) Identifying key use cases that automated vehicles will need to address and developing performance requirements and test procedures; and

(3) Performing research on the underlying electronic control systems to develop functional safety requirements and potential reliability requirements in the areas of diagnostics, prognostics, and failure response (fail safe) mechanisms and to support requirements in the area of vehicle cybersecurity.

RESPONSE TO WRITTEN QUESTIONS SUBMITTED BY HON. FRANK R. LAUTENBERG TO HON. DAVID L. STRICKLAND

Question 1. In 2011, 9,878 people were killed in alcohol-impaired driving crashes, accounting for nearly one-third of all traffic-related deaths in the U.S. The Centers for Disease Control and Prevention found that re-arrest rates for drunk driving decreased by 67 percent for convicted drivers with ignition interlocks as compared to those who just had their license suspended. The National Transportation Safety Board released a recommendation on May 14 that ignition interlocks be required for all first time offenders, and I plan to reintroduce legislation that would do just that.

Question 1a. What would the safety benefits be of requiring ignition interlocks for all first time drunk drivers?

Answer. Ignition interlocks have been shown to be highly effective in preventing repeat drunk driving offenses when installed on vehicles driven by drunk driving offenders. This preventative effect has been demonstrated for both those who have been convicted for their first drunk driving offense and those who have had one or more previous offenses. While it is clear that the safety benefit of ignition interlocks increases as more offender vehicles are equipped, estimates of potential lives saved are dependent on several other factors, such as the length of time during which they are installed.

Question 1b. Should ignition interlocks be mandatory for all convicted drunk driving offenders?

Answer. States can extend the benefits of ignition interlocks by requiring their use by first-time offenders as well as repeat offenders. MAP–21 includes an incentive grant for states that enforce a mandatory alcohol-ignition interlock law for all individuals convicted of driving under the influence of alcohol or of driving while intoxicated.

Question 1c. Some opponents of my legislation claim that this would place an undue financial burden on states to meet the requirement. What are the costs to states for highway crashes related to drunk driving?

Answer. Preliminary research indicates that crashes involving an impaired driver (.08+ BAC) may cost states and localities over $2 billion annually in medical payouts, insurance administration, adjudication, lost revenues, incident management, police, fire department, and other crash related costs.

Question 2. For the first time since 2005, more people died on U.S. roads last year than the year before. Total fatalities increased by more than five percent in 2012, and motorcycle deaths have increased by almost three times that—14.7 percent.

Question 2a. What is the biggest contributing factor for these motorcycle fatalities?

Answer. A number of factors contribute to changes in the number of motorcycle fatalities including the number of vehicle miles travelled and the use of helmets that comply with Federal Motor Vehicle Safety Standards. Motorcycles continue to increase in popularity. While registration information is not yet available for 2012, states report that registrations increased more than 5 percent between 2010 and 2011. Registrations increased by more than 70 percent between 2001 and 2011.

Question 2b. What would the safety benefits be of requiring helmets for all motorcycle riders?

Answer. NHTSA estimates that in 2011, 703 additional motorcyclist lives could have been saved if all riders had been wearing helmets meeting Federal Motor Vehicle Safety Standards.

Question 2c. Would you support a requirement that all motorcyclists wear helmets?

Answer. NHTSA supports the use of motorcycle helmets by all riders. Motorcycle helmet laws covering all riders, often referred to as universal helmet laws, are the most effective method of increasing and maintaining helmet use and avoiding fatalities and disability due to head injuries. Over the past 30 years, research has consistently shown the negative effects of weakening or repealing motorcycle helmet use laws. The weight of the evidence is that repeal of helmet use laws decreases helmet use, and that states that repeal universal helmet use laws experience increased fatalities and injuries. Conversely, states that have adopted or reenacted universal laws have experienced significant increases in helmet use and declines in motorcyclist fatalities and injuries.

Question 2d. In addition to a mandatory helmet law, what other steps would help reduce motorcycle fatalities?

Answer. Increasing helmet use and decreasing impaired riding could have substantial effect on reducing motorcycle fatalities. In 2011, 30 percent of fatally injured motorcycle riders (1,298 riders) had a blood alcohol concentration of .08 or greater. This rate is higher than for drivers of any other type of vehicle. States can address impaired riding with education and law enforcement programs. Other measures that can affect motorcycle safety include rider training and ensuring that riders have proper license endorsements. Finally, NHTSA is pursuing rulemaking to establish an enforcement policy regarding "novelty" motorcycle helmets, which are noncompliant helmets that provide inadequate protection. The rulemaking would also add an appendix to FMVSS No. 218 to serve as a guide for motorcyclists and local law enforcement personnel in identifying compliant motorcycle helmets.

Question 3. Speed limiters can make our highways safer by keeping trucks at safe speeds; heavy commercial trucks have been equipped with speed limiting capabilities since 1992. The Federal Motor Carrier Safety [Administration] published a study last year that found a heavy truck without an engaged speed limiter is twice as likely to be in a highway crash as one that has a speed limiter. NHTSA has been considering a rulemaking to require the installation of speed limiting devices on heavy trucks since 2011.

Question 3a. When can we expect to see a final rulemaking?

Answer. DOT expects to issue a notice of proposed rulemaking by the end of this year and will consider public comments as we work towards a final rule.

Question 3b. Will you commit to working with me to ensure that this rulemaking is completed in a timely manner?

Answer. I commit to working toward the completion of this rulemaking as expeditiously as possible.

Question 3c. How do speed limiters and electronic logging devices work together to prevent crashes?

Answer. The two devices work together to improve safety in the following way:

(1) Speed limiters will slow heavy trucks currently driving at higher speeds; and

(2) Electronic logging devices will deter truck drivers from making up the difference in miles traveled at slower speeds by driving extended hours.

Requiring both devices will increase public safety by limiting the speeds of heavy trucks and the likelihood of fatigued drivers operating these vehicles on roadways.

Question 4. Many companies are already investing in advanced technologies, such as automatic braking systems.

Question 4a. Does the agency have adequate staffing and funding to ensure these rapidly changing technologies are safe and appropriate?

Answer. Safe vehicles are a vital component of preventing roadway fatalities, and NHTSA has a long history of ensuring that the vehicles on our nation's roadways are the safest they can be. NHTSA already has substantial and growing expertise in technologies related to advanced vehicle automation. However, with new sophisticated electronic control systems and alternative fuel systems of varying types emerging in the market, we need to expand our ability and capacity to test, monitor and trouble-shoot new technologies as expeditiously and efficiently as possible. With many new crash avoidance technologies under development, expanding our capability to test human interactions with these systems is also imperative. We will fur-

ther explore ways for NHTSA to address these new challenges across the spectrum of our vehicle safety program responsibilities. The President's FY 2014 budget proposed to undertake activities to provide the capability of advanced testing of emergent technologies at our Vehicle Research and Test Center and to hire additional electronics and electrical engineers.

Question 5. Approximately every 50 minutes, one life is lost to drunk driving. Beginning in 2008, the auto industry entered a five-year, cooperative program with the National Highway Safety Administration (NHTSA) to invest in emerging technologies that would stop drivers from operating a vehicle if drunk, such as Driver Alcohol Detection System for Safety (DADSS) technology. The 2012 transportation reauthorization law, MAP–21, provided funds to NHTSA to continue this research.

Question 5a. What funding levels are needed to adequately support this research?

Answer. The program is currently in the Phase 2 development phase, which will result in research prototypes in 2014. While impressive progress has been to date, significant additional development is needed before the technology is ready for mass-production. Additional research is needed to continue the technology development, perform sub-system development and validation, address circumvention concerns, increase the amount of usability testing, improve standard calibration devices and perform reliability, repeatability and durability testing on actual vehicles. This effort is currently estimated to be ready for auto industry handoff and integration in 2018. At least $5 million per year for each of the upcoming five years is needed to perform the required research.

Question 5b. The designated five-year cooperative program between the auto industry and NHTSA runs through 2013. What will the auto industry's commitment to this technology be beyond 2013?

Answer. NHTSA is currently in discussions about a new research and development agreement with auto industry partners, and new cooperative agreement is expected to be finalized. The new agreement will represent a significant increase in the Department's investment in technologies that could prevent drunk drivers from operating vehicles. We are now working with our partners to determine the level and type of support they will provide as part of the new cooperative agreement.

Question 6. According to testimony, vehicle-to-vehicle technology has the potential to prevent 80 percent of crashes, when fully deployed. However, it will be more than 10 years before this technology is deployed.

Question 6a. What are the safety benefits of this technology during the scale-up of deployment?

Answer. Vehicle-to-vehicle or V2V technology has the potential to address 80 percent of crashes of unimpaired drivers. This statement indicates that the technology can be applied to 80 percent of the crashes, but it does not suggest that every crash will be avoided. The current research is collecting data and conducting analysis and evaluation to estimate the effectiveness of the technology and the benefits that would result with consideration given to various percentages of fleet penetration. However, even as deployment of V2V is scaling up, safety benefits would be substantial for vehicles equipped with the technology, particularly where vehicle to infrastructure applications also are deployed.

Question 6b. What can be done to take advantage of incremental safety benefits?

Answer. Given that a message from one vehicle needs to be received by another, the benefits will depend on the level of technology deployed. DOT is analyzing various deployment scenarios to estimate incremental benefits over the scale-up period. The primary benefits are from warning a driver and avoiding a crash. However, in the scale-up period some vehicles may only transmit a message through the installation of aftermarket devices. Vehicles with these devices would provide the benefit of being able to be "seen" by vehicles with devices that both receive messages and provide warnings. The mixture of original equipment and after-market devices is likely to produce significant safety benefits even early in the scale-up period.

RESPONSE TO WRITTEN QUESTIONS SUBMITTED BY HON. AMY KLOBUCHAR TO HON. DAVID L. STRICKLAND

Question 1. Administrator Strickland, following incidents in 2009 and 2010 of Sudden Unintended Acceleration in Toyota vehicles, this Committee found that NHTSA lacked the authority, expertise, and resources to fully investigate possible electronics-based defects. A NASA/NHTSA report in 2011 noted ". . . features such as vehicle-to-vehicle (V2V) and vehicle-to-infrastructure (V2I) communications will likely require further increases in software complexity." MAP–21 took steps to address this lack of electronic expertise and capacity at NHTSA by establishing a

Council for Vehicle Electronics, Vehicle Software, and Emergency Technology to improve the agency's expertise in passenger motor vehicle electronics and will focus on reliability, cybersecurity, and emergency technologies.

Question 1a. I understand NHTSA recently convened the Council, so what can you tell me about the group's work and what it will mean for NHTSA's ability to properly detect defects in these complex systems, assess their potential causes and propose solutions?

Answer. According to National Academy of Science's (NAS) report *The Safety Promise and Challenge of Automotive Electronics,* NHTSA's decision to close its investigation of Toyota's electronic throttle control as a possible cause of unattended acceleration was justified. Furthermore, the National Aeronautics and Space Administration's (NASA) report on unintended acceleration did not find any evidence contradicting NHTSA's conclusions in its investigation. The agency has issued standards for some electronic safety systems, such as electronic stability control or ESC, and has successfully conducted many investigations involving defective or noncompliant electronics. At the same time, NHTSA continues to take steps to further increase our expertise in this important field.

To coordinate and manage agency activities in the area of vehicle electronics, the agency established the Council on Vehicle Electronics, Vehicle Software and Emerging Technologies, as required by MAP–21. The Council meets on a bi-monthly basis to discuss and share information. The mission of the group is to broaden, leverage and expand the agency's expertise in motor vehicle electronics and to continue ensuring that these technologies enhance vehicle safety. Currently the Council is assessing the need for safety standards for vehicle electronics by overseeing a data analysis of the types and frequency of electronic control system failures. The results will be a key input to the report to Congress on the need for safety standards in the electronics area. We expect to deliver this report in 2014.

In addition to the Council, NHTSA has expertise it can access both within the agency and outside specialists in the area of vehicle electronics. As supported by the findings of the NAS and NASA reports, the agency believes it has the needed expertise to address defects issues that may arise in the near term. However, in the long term, we will need to expand our ability and capacity to test, monitor and troubleshoot new technologies as expeditiously and efficiently as possible. We will further explore ways for NHTSA to address these new challenges across the spectrum of our vehicle safety program responsibilities. The President's FY 2014 budget proposed to undertake activities to provide the capability of advanced testing of emergent technologies at our Vehicle Research and Test Center and to hire additional electronics and electrical engineers.

Question 2. Administrator Strickland, NHTSA oversees the NCAP program which is a rating system for vehicle safety uses by consumers in the market for new cars. The current system rates vehicles on frontal- and side-crash resistance, electronic stability control, lane departure warning, as well as other safety systems. I know NHTSA is considering an update to the NCAP program and recently released a request for comment seeking input on which advanced safety systems should be included in the new NCAP rating system.

Question 2a. Can you tell me what the agency looks at when it considers adding new safety systems to the NCAP program?

Answer. When considering a new advanced safety system for possible inclusion into NCAP, NHTSA analyzes the following:

- Is there a safety benefit that could be obtained and that can be demonstrated in the form of projected lives saved, injuries prevented and crashes reduced?
- Are there objective test procedures or industry standards that would measure performance differences?
- Is the technology mature enough for mass production?
- Would the technology create the market forces necessary to encourage the adoption into NCAP?

Question 2b. Do you find the NCAP system to be a useful way to create incentives for auto manufacturers?

Answer. Yes, NCAP is useful and successful in creating safety incentives for auto manufacturers. When the agency began rating vehicles for frontal impact safety, fewer than 30 percent of vehicles tested received the 4 or 5 star frontal crash safety rating for the driver seating position. By 2006, this increased to 98 percent. Implementation of side crash and rollover resistance NCAP ratings programs achieved safety improvements even more quickly.

Therefore, in 2010, we raised the safety bar by incorporating more stringent crash tests, making it harder for vehicles to achieve 4 or 5 stars. Since then, vehicle manufacturers have responded positively with additional safety improvements. NCAP's advanced technology recommendations have also increased the installation rates of advanced crash avoidance features. For example in 2010, 10 percent of the new vehicle models sold in the U.S. had lane departure warning or forward collision warning systems as optional safety features. By 2012, this increased to 25 percent.

RESPONSE TO WRITTEN QUESTIONS SUBMITTED BY HON. DAN COATS TO HON. DAVID L. STRICKLAND

Question 1. In each year from 1992 to 2007, 40,000 lives were lost and nearly 3 million people were seriously injured in vehicular crashes. The rate of fatalities per crash per miles driven has remained nearly constant for 15 years (approximately 11 fatalities per billion miles driven per year) at an estimated economic cost of nearly $231 billion annually. There is evidence that increased utilization of active safety technologies, including collision imminent braking, radar, driver monitoring and workload management, could significantly improve safety on our roads. The Insurance Institute for Highway Safety (IIHS) estimates the measurable benefits of crash avoidance features on passenger vehicles as a 32 percent reduction in crashes, a 21 percent reduction in injuries and a 31 percent reduction in fatalities. That is well over 10,000 lives saved per year. Many of these technologies are in use, but they are in relatively few vehicles. At the current rate of acceptance, it is estimated that active safety technologies will not significantly impact crash statistics for 20 years.

- What steps are being taken by NHTSA to examine active safety technologies through the NCAP program?
- What is NHTSA doing to improve consumer understanding of the benefits of active safety technologies?

Answer. NHTSA has undertaken several steps to examine active safety technologies through the New Car Assessment Program (NCAP). These steps include the following:

- We published a "Request for Comments" notice on April 5, 2013 (78 FR 20597), requesting public input to help identify the potential areas for improvement to NCAP that have the greatest potential for producing safety benefits, including crash avoidance technologies. We will review the comments and use this input to guide further decisions on providing crash avoidance technology information through NCAP, including developing a draft 5-year research plan as well as longer term upgrades that the agency intends to pursue making to NCAP.
- Concurrently, NHTSA is conducting research and working towards agency decisions on the next actions for certain advanced technology systems such as crash imminent braking and dynamic brake support. If research involving a particular safety technology indicates that it is sufficiently developed, the agency may decide to pursue a requirement through a new safety standard instead of or in addition to recommending the technology through NCAP.

NHTSA has also undertaken several steps to improve consumer understanding of the benefits of active safety technologies. These steps include the following:

- Beginning with model year 2011, the agency added to NCAP information about the presence of advanced crash avoidance technologies in vehicles. Technologies shown to have a safety benefit and that meet NHTSA's performance criteria are recommended to consumers on *www.safercar.gov,* where all NCAP ratings are posted.
- Recently launching a "SaferCar" mobile application. This application includes information about the availability of recommended advanced technologies.
- Developed videos, vehicle illustrations and fact sheets to educate the public and promote advanced crash avoidance technologies.
- Working with our partners, such as independent automotive websites, to increase awareness and promote certain advanced crash avoidance technologies.
- Conducting comprehensive consumer research on advanced crash avoidance technologies to gauge understanding of these technologies and develop effective approaches for communicating these technologies to consumers.
- Publishing the agency's Automated Vehicles Policy Statement concerning vehicle automation, including plans for research on related safety issues and rec-

ommendations for states related to the testing, licensing, and regulation of "autonomous" or "self-driving" vehicles.

Question 2. Congress expanded the New Car Assessment Program (NCAP) with the creation of the Passenger Motor Vehicle Program in 2012 (Section 31305 of MAP–21, P.L. 112–141). Specifically, The Passenger Motor Vehicle Program directs the Secretary of Transportation to maintain a program that develops information on passenger motor vehicles, including crash avoidance and other areas that will improve the safety of passenger motor vehicles. The Secretary is directed to provide this information to consumers, and the Secretary also may require auto dealers to distribute this information to consumers. What are your plans for implementation of the Passenger Motor Vehicle Information Program's requirements on crash avoidance?

Answer. Currently, three advanced crash avoidance technologies (Lane Departure Warning, Forward Collision Warning, and Electronic Stability Control) being recommended as part of NCAP. The agency added to NCAP information about the presence of advanced crash avoidance technologies in vehicles. Technologies shown to have a safety benefit and that meet NHTSA's performance criteria are recommended to consumers on *www.safercar.gov.* We also distribute comprehensive vehicle safety information at various auto shows across the country, including factsheets, media templates, decals, banners and logos for dealers and manufacturers to use in educating consumers. NHTSA is developing an infographic (animated schematic) to describe the advanced technologies and educate the general public, and we plan to conduct a comprehensive consumer research program to understand how best to convey to consumers the importance of advanced crash avoidance technologies. As noted above, we also published a "Request for Comments" notice on April 5, 2013 (78 FR 20597) requesting public input to help identify the potential areas for improvement to NCAP that have the greatest potential for producing safety benefits, including crash avoidance technologies.

Question 3. In its FY13 budget request, NHTSA states: "NCAP is also considering adding additional crash avoidance advanced technology to the current list of crash avoidance technologies. NCAP recommends Lane Departure Warning, Forward Collision Warning, and Electronic Stability Control to consumers, when a manufacturer demonstrates the technology on its vehicle passes the NCAP performance specification. We plan to make a decision on the next advanced technology in FY 2012."

- What progress has been made in this effort?
- How is this information communicated to consumers?
- Will NHTSA include the results of these tests on the Mulroney sticker to ensure that consumers are fully informed about the advantages of crash avoidance technologies? If so, when? If not, why not?
- Based on the test criteria for these features already developed in Europe for pending EuroNCAP updates for active safety, and additionally for pending IIHS ratings, are there plans at NHTSA to work with these organizations to harmonize test criteria?

Answer. The agency has been evaluating several advanced technologies that may potentially be added to NCAP. Specifically, NHTSA has established a multi-disciplinary project team to evaluate crash imminent braking and dynamic brake support. We also published a "Request for Comments" notice on April 5, 2013 (78 FR 20597) requesting public input to help identify the potential areas for improvement to NCAP that have the greatest potential for producing safety benefits, including crash avoidance technologies.

As described above, information regarding the three recommended crash technologies (Lane Departure Warning, Forward Collision Warning, and Electronic Stability Control) is communicated to consumers via the agency's website (*www.safercar.gov*), the agency's "SaferCar" mobile application, and various independent websites.

With respect to the Monroney label, we published a final rule on July 29, 2011 (76 FR 45453) revising the safety rating information section of the label. At that time, we stated that, due to a lack of space, we did not include advanced technologies on the Monroney label. In addition, we indicated that we would conduct a comprehensive consumer research program to determine whether consumers would like to have this information at the point of sale. As consumers become more aware and interested in the advanced technologies, we may consider including these technologies on the Monroney label. In the meantime, we have launched a "SaferCar" mobile application to allow consumers to access advanced crash avoidance technology information from mobile devices.

NHTSA is the first entity in the world to have performance test procedures for the three advanced technologies that are recommended in NCAP. We published performance-based test procedures for these technologies in 2008. As we are currently developing test procedures for forward collision avoidance and mitigation, we have discussed and shared our test procedures with other entities that have relevant test procedures. For example, our test procedure for forward collision avoidance and mitigation was presented to the World Forum for Harmonization of Vehicle Regulations (WP.29). Overall, we seek to harmonize with other rating programs similar to NCAP where possible, as long as the harmonization does not detract from the safety benefits that would result from vehicle designs passing the NHTSA performance test procedures.

RESPONSE TO WRITTEN QUESTIONS SUBMITTED BY HON. FRANK R. LAUTENBERG TO MITCH BAINWOL

Question 1. Approximately every 50 minutes, one life is lost to drunk driving. Beginning in 2008, the auto industry entered a five-year, cooperative program with the National Highway Safety Administration (NHTSA) to invest in emerging technologies that would stop drivers from operating a vehicle if drunk, such as Driver Alcohol Detection System for Safety (DADSS) technology. The 2012 transportation reauthorization law, MAP–21, provided funds to NHTSA to continue this research. What funding levels are needed to adequately support this research?

Answer. The current five-year cooperative program will culminate late this year with each of the competing DADSS technologies (one breath-based and one touch-based) being incorporated into a single research vehicle for further evaluation. At this juncture, the DADSS technologies have not fully achieved the key performance specifications established that will be necessary to help garner consumer acceptance of the technologies, *i.e.,* speed, accuracy, and precision of measurement. The gaps in performance are being quantified, and more importantly, the research remaining to close these gaps will be identified. At present, it is anticipated that an additional 5 years of research and testing (including on-road, real-world testing and human subject testing) is needed to be able to determine whether one or more DADSS technologies can be commercialized. Until side by side testing and validation of the two competing technologies in the research vehicles are completed and the gaps in performance are quantified, consistent funding of these research activities will be required. An informed assumption is that at least $5 million a year through Fiscal Year 2018 is needed.

Question 2. The designated five-year cooperative program between the auto industry and NHTSA runs through 2013. What will the auto industry's commitment to this technology be beyond 2013?

Answer. The automakers involved in the current cooperative effort represent roughly 99 percent of new light vehicle sales in the U.S. Their commitment to the current effort has been to provide intellectual support (*e.g.,* development of the DADSS performance specifications and the current effort's 5-year research plan) in addition to funding support. These automakers are encouraged that the current effort has transformed a highly speculative idea into a robust technology concept with potential for commercialization. The technical and public acceptance challenges in commercializing the DADSS technology are considerable, but the potential safety benefits are promising. An analysis by the Insurance Institute for Highway Safety estimates that if driver blood alcohol concentrations were no greater than 0.08 percent—the legal limit in all 50 states—7,082 of the 10,228 alcohol-impaired road user fatalities occurring in 2010 may have been prevented. Given this, automakers remain committed to completing the research needed to be able to determine whether one or more DADSS technologies can be commercialized and accepted by the driving public.

Question 3. According to testimony, vehicle-to-vehicle technology has the potential to prevent 80 percent of crashes, when fully deployed. However, it will be more than 10 years before this technology is deployed. What are the safety benefits of this technology during the scale-up of deployment?

Answer. According to a NHTSA report, connected vehicles may have the potential to address 80 percent of non-impaired crashes in the light-vehicle fleet once sufficient market penetration has been achieved (another 10+ years). In addition, we can anticipate environmental benefits from the congestion mitigation opportunities and potential fuel savings associated with the technology. Deployment on a wide array of light duty and medium/heavy duty vehicles is possible. In the interim, as the technology is implemented on a more piece-meal basis, we will see benefits associated with greater warnings for drivers of potential crash situations and which tech-

nologies which may assist with avoiding an accident (such as application of brakes and adjustable cruise controls).

Question 4. What can be done to take advantage of incremental safety benefits?

Answer. One of the most important things that can be done to take advantage of the incremental benefits associated with this technology is to ensure that the spectrum band associated with this technology, Dedicated Short Range Communications (DSRC), be highly secure and protected from any potential harmful interference. Given the potential life-saving applications of DSRC and inherent chaotic nature of roadway travel it is imperative that the signals and warnings that DSRC systems provide be free from harmful interference.

RESPONSE TO WRITTEN QUESTIONS SUBMITTED BY HON. FRANK R. LAUTENBERG TO JEFFREY J. OWENS

Question 1. According to testimony, vehicle-to-vehicle technology has the potential to prevent 80 percent of crashes, when fully deployed. However, it will be more than 10 years before this technology is deployed. What are the safety benefits of this technology during the scale-up of deployment?

Answer. Delphi believes the most effective active safety technologies to prevent crashes are sensing devices such as radar and cameras that can provide full 360 degree sensing coverage around the vehicle with a high degree of accuracy. These sensors can warn drivers of potential accidents and can allow vehicles to react when drivers do not, regardless of whether the threat is another vehicle, pedestrian, or other object.

The addition of vehicle to vehicle (V2V) technology is an enhancement to these sensors that enables vehicles to share information dynamically about their position, direction, and mass—not just to each other but also to the surrounding traffic network. Use of V2V technology independently (without vehicle sensors) would require that *all* vehicles have the technology to be effective and to "see" each other. V2V alone would not protect drivers from other vehicles without V2V technology, nor would the systems work with pedestrians or other moving objects.

The benefits that could be achieved with the implementation of sensors such as radar and cameras would be to enable drivers to be informed of potential collisions with any object or lane departure event, and for the vehicle to react when the driver cannot. These technologies, on the road today, can lead to measurable reductions in collisions and related injuries and fatalities.

Question 2. What can be done to take advantage of incremental safety benefits?

Answer. A roadblock to the widespread usage of advanced active safety technology is consumer awareness. Although these technologies have been on the road since 1999, relatively few vehicles are equipped today with these features, despite their availability on multiple vehicles and lower costs. The enhancement of today's NHTSA New Car Assessment Program (NCAP) to include ratings for these crash avoidance technologies would help to drive consumer awareness, giving drivers an informed choice for their vehicle purchase. These ratings should be clearly included on the vehicle Monroney label, along with consumer information campaigns to inform the public of the benefits of these life-saving technologies.

RESPONSE TO WRITTEN QUESTIONS SUBMITTED BY HON. FRANK R. LAUTENBERG TO DR. PETER F. SWEATMAN

Question 1. Despite many improvements in road safety in the U.S., the current safety level is far below the level of the best-performing countries. For example, speed limiters are compulsory for heavy trucks in Sweden, the Netherlands, and the United Kingdom, but there is currently no such requirement in the U.S. In addition, while ignition interlock technology is currently utilized in the U.S., ignition interlocks are not required for all first-time drunk driving offenders despite the fact the NTSB has recommended such a requirement.

Question 1a. Would a speed limiter "top-speed" requirement on heavy trucks improve safety on our Nation's roads?

Question 1b. Would expanded use of ignition interlocks improve safety on U.S. roads?

Answer. While it is true that the overall U.S. fatality rate (both by population and by distance traveled) is higher than the best-performing countries, we find some interesting variations when we consider fatality rates for specific categories of vehicles such as cars and heavy trucks. In terms of international comparisons, the U.S. heavy truck fatality rate fares considerably better than the rate for cars. This is

partly because a relatively high proportion of U.S. heavy truck travel occurs on high-standard divided roadways. Such roadways have lower heavy truck crash rates than two-way undivided roads. So the U.S.'s performance in heavy truck fatality rates is better than its performance in passenger car crash rates, which represent the bulk of the Nation's highway safety performance.

Having said that, technological means of controlling truck speed would reduce heavy truck crash risks. Experience in other countries has shown that the severity of heavy trucks crashes can be reduced when speed limiters are compulsorily fitted. Such improvements will occur on higher-speed roadways such as interstates. I would note that the positive impact of a requirement to fit speed limiters would be reduced somewhat by the fact that a significant number of the larger fleets already voluntarily fit speed limiters, and overseas experience shows some propensity to tamper with speed limiter settings. A speed limiter requirement is therefore desirable, but would not have as high priority as requirements for other safety technology, such as electronic stability control, forward collision warning or collision mitigation braking.

Alcohol impairment has a very significant impact on the U.S. highway fatality rate. Not enough is being done to reduce the very serious societal consequences of drink-driving. Experience in other countries has shown that deaths and injuries caused by drink-driving can be reduced through behavioral interventions, including media campaigns and stringent, purposeful enforcement with very serious consequences, even for first-time offenders. Technological interventions, such as interlocks, have not yet been fully perfected in the sense that the reliability may not be commensurate with the gravity of the intervention for fleet-wide installation. If current-technology interlocks were fitted to the majority of the U.S. car fleet, normal automotive levels of reliability could result in many legitimate trips being prevented, and hence significant consumer/public dissatisfaction. However, it makes sense for drink-driving offenders to be required to fit current-technology interlocks, regardless of the reliability issue. Such a requirement would likely improve safety on U.S. roads.

Additionally, NHTSA and a group of automakers are currently researching the potential for a much higher-performing interlock, which could result in vastly improved capability and reliability, and could therefore reduce or eliminate the chance for "false-positives". This research should be continued, as it could have very significant benefit for vehicle safety.

Question 2. According to testimony, vehicle-to-vehicle technology has the potential to prevent 80 percent of crashes, when fully deployed. However, it will be more than 10 years before this technology is deployed.

Question 2a. What are the safety benefits of this technology during the scale-up of deployment?

Question 2b. What can be done to take advantage of incremental safety benefits?

Answer. The potential safety benefit for V2V is significant. As such we should proceed swiftly and diligently with finalizing the research and moving into a regulatory and deployment stage for V2V.

The effectiveness of nearly every safety technology is dependent on its introduction curve and the sale of equipped new vehicles, and in many regards V2V is no different. Of course, since it is a cooperative technology, V2V effectiveness will follow a "delayed" curve. But this delay will be largely overshadowed by the overall effectiveness of the technology, and should not be a reason to stall or disrupt deployment.

The safety benefits of the technology at relatively low densities of V2V-equipped vehicles are being probed in the Ann Arbor Safety Pilot Model Deployment, where many thousands of useful interactions have been generated with less than 3,000 equipped vehicles.

While the density of V2V-equipped vehicles in the traffic stream is clearly a governing factor in the magnitude of the safety benefit, other factors affect the rate of beneficial safety messages. In situations where traffic streams interact, the rate of safety messages increases exponentially with the density of equipped vehicles.

Having said that, we should not rely solely on the new-vehicle fitment of V2V technology to provide the large safety benefits offered by connected vehicle technology. We should be accelerating research into deployment of Dedicated Short Range Communication (DSRC) safety through Vehicle Awareness Devices (VSDs), which act as a beacon for other equipped vehicles to "see", and Aftermarket Safety Devices (ASDs), which can provide warnings and information to the driver as long as they are designed and installed properly. These devices can be incorporated into many existing products, such as retrofitted communications and navigation systems, and potentially even cell phones. These devices, if proven to be effective for safety,

could provide a very short path to safety effectiveness. Additionally, these devices can potentially provide safety applications and benefits for vulnerable road users, such as pedestrians and bicyclists.

The deployment of retrofit and aftermarket devices in existing vehicles is therefore a critical tool in accelerating the safety benefits.

Importantly, there will be a need for government-supported efforts to continually maximize and accelerate the benefits for the owners of both equipped and retrofitted vehicles. These efforts need to include vehicle-to-infrastructure (V2I), through large regional deployments, and address the incidence and usefulness of information broadcast to the vehicle. The fitment of equipment in the infrastructure is a critical factor in accelerating safety benefits. And there is exponential benefit to be found in selectively fitting equipment at infrastructure "black-spots" such as high-accident-rate intersections. The U.S. Government must accelerate the pace of V2I research and take the lead to ensure the earliest deployment of connected infrastructure.

As the rate of beneficial safety messages increases rapidly in large regional deployments, we will be in a stronger position to design more powerful V2V safety applications, and to more fully appreciate their benefits. We will also begin to see whether community-based influences could come into play. For example, we have found that members of the Ann Arbor community see common cause in having their vehicles fitted. Unlike all previous safety systems, V2V not only has potential benefit for those who travel in your vehicle, but also for every other vehicle you encounter in your community and out on the highway.

Larger-scale regional deployments of V2V and V2I are needed to bridge between model deployments, such as in Ann Arbor, and a national deployment. Such regional deployments would benefit from utilizing large company and government vehicle fleets, and should be enhanced with roadside equipment in the infrastructure. Federal funding will be needed to support the design and execution of such deployments, including interoperability of equipment, promoting the uptake of aftermarket devices, data collection and analysis, community outreach, and the preparation of any additional standards, protocols and incentives required to accelerate mainstream deployment.

RESPONSE TO WRITTEN QUESTIONS SUBMITTED BY HON. FRANK R. LAUTENBERG TO DR. JOHN D. LEE

Question 1. According to testimony, vehicle-to-vehicle technology has the potential to prevent 80 percent of crashes, when fully deployed. However, it will be more than 10 years before this technology is deployed. What are the safety benefits of this technology during the scale-up of deployment?

Answer. Although the turnover of the U.S. automotive fleet delays the full deployment of vehicle-to-vehicle and vehicle-to-infrastructure technology for many years, substantial safety benefits might be seen much earlier. Two factors might accelerate the safety benefits before full-scale deployment:

(1) Aftermarket devices could make it feasible to equip existing vehicles with some elements of vehicle-to-vehicle technology. Just as aftermarket navigation and entertainment systems enable drivers to upgrade their existing vehicles, aftermarket vehicle-to-vehicle systems could provide drivers with advanced technology before they purchase a new car. Even advances in cellphone technology might serve to provide some features associated with full deployment of vehicle-to-vehicle technology, as seen in the Waze app, and in a recent demonstration of how vehicle-to-bicycle alerts can be provided through cellphones (Dozza, M., & Gustafsson, P. (2013). BikeCOM—A cooperative safety application supporting cyclists and drivers at intersections. *Proceedings of the 3rd Conference of Driver Distraction and Inattention, Gothenbrug, 4–6 September, 2013.*).

(2) Substantial benefits of vehicle-to-vehicle technology accrue to the traffic stream rather than the individual driver. The most obvious beneficiary of vehicle-to-vehicle technology is the driver who receives its warnings; however, the surrounding drivers can benefit as well. A driver who brakes in response to a vehicle-to-vehicle warning of a crash on the road ahead will lead surrounding drivers to slow even through they might not receive the warning. Likewise, a simulation of traffic showed that when 20 percent of vehicles engaged adaptive cruise control traffic jams were avoided. Not all cars need to have the same technology for everyone to benefit. Davis, L. C. (2004). Effect

of adaptive cruise control systems on traffic flow. *Physical Review E, 69*(6), 066110. doi:10.1103/PhysRevE.69.066110.

Question 2. What can be done to take advantage of incremental safety benefits?

Answer. (1) Evaluate and promote technology that complements the traditional automotive model—technology incorporated by the automotive manufactures—such as aftermarket technology and technology that can be carried in on smart phones and similar devices.

(2) Evaluate and promote technology based on its benefit to both the driver whose car is equipped and on the benefit to the surrounding vehicles that are not equipped.

RESPONSE TO WRITTEN QUESTION SUBMITTED BY HON. JOHN THUNE TO MITCH BAINWOL

Question 1. In your testimony you state that connected vehicle spectrum in the 5.9 gigahertz band must remain "solely dedicated to auto communications technologies." This does not leave open the possibility that connected vehicles could share the spectrum with unlicensed Wi-Fi, even if Wi-Fi devices are found not to cause interference with connected vehicles. I believe, however, that the best possible public policy outcome is if the engineers can find a way for both technologies to coexist in the 5.9 gigahertz band. If it turns out that Wi-Fi will not interfere with connected vehicles, do you still believe that Wi-Fi should not be allowed to operate in the 5.9 band?

Answer. Thank you for the opportunity to clarify.

The Federal Communications Commission (FCC) proposes to make available an additional 195 MHz of spectrum for use by unlicensed wireless devices. This would equate to a 35 percent increase in the amount of spectrum currently allocated for such use. Approximately two–thirds of this proposed increase would be achieved by opening the 5.4 GHz frequency band (5.35–5.47 GHz). The balance of this increase would come from the 5.9 GHz band (5.85–5.925 GHz).

The 5.9 GHz band is allocated on a *primary* basis to Department of Defense (DOD) radar systems for military surveillance and test range instrumentation systems, fixed satellite (earth to space) uses by the National Aeronautics and Space Administration (NASA), the National Oceanic and Atmospheric Administration (NOAA) and the Department of Energy (DOE), and non-federal operations limited to Dedicated Short Range Communication Service (DSRC) systems.

Given these critical safety and security uses, the Alliance believes that the FCC should adopt a "do no-harm" strategy *until testing is complete.* Auto manufacturers, suppliers and the Department of Transportation (DOT) have spent hundreds of millions of dollars on research and development using DSRC systems to make connected vehicles a reality and achieve the potential safety, mobility and environmental benefits for the American transportation system, as discussed at the hearing. At the same time, we recognize the potential economic benefits from expanding wireless access; therefore, we are not opposed to sharing the 5.9 GHz spectrum provided that can be accomplished *without harmful interference or channel congestion* for safety-critical systems.

The Alliance's fundamental concern is that the timelines announced by the National Telecommunications and Information Administration (NTIA) for testing for potential interference with these systems (mid-2014) and the FCC for completing the 5.9 GHz rulemaking (end of 2013) are out of sync. We agree with you that potential exists to achieve a good public policy outcome both for vehicle safety and for expanded wireless access, but the requisite testing must be completed, and any outstanding issues must be resolved before a final rule is issued.

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