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SELF-DRIVING CARS: LEVELS OF AUTOMATION

TUESDAY, MARCH 28, 2017

House of Representatives,

Subcommittee on Digital Commerce and Consumer Protection,

Committee on Energy and Commerce

Washington, D.C.

The subcommittee met, pursuant to call, at 10:00 a.m., in Room 2322 Rayburn House Office Building, Hon. Robert Latta [chairman of the subcommittee] presiding.

Present: Representatives Latta, Harper, Lance, McKinley, Kinzinger, Bilirakis, Mullin, Walters, Costello, Walden (ex officio), Schakowsky, Clarke, Cardenas, Dingell, Matsui, Welch, Kennedy, Green, and Pallone (ex officio).

Staff present: Ray Baum, Staff Director; Blair Ellis, Digital Coordinator/Press Secretary; Melissa Froelich, Counsel,

Digital Commerce and Consumer Protection; Adam Fromm, Director of Outreach and Coalitions; Giulia Giannangeli, Legislative Clerk, Digital Commerce and Consumer Protection/Communications and Technology; Paul Nagle, Chief Counsel, Digital Commerce and Consumer Protection; Olivia Trusty, Professional Staff Member, Digital Commerce and Consumer Protection; Madeline Vey, Policy Coordinator, Digital Commerce and Consumer Protection; Hamlin Wade, Special Advisor, External Affairs; Michelle Ash, Minority Chief Counsel, Digital Commerce and Consumer Protection; Jeff Carroll, Minority Staff Director; Lisa Goldman, Minority Counsel; Caroline Paris-Behr, Minority Policy Analyst; Matt Schumacher, Minority Press Assistant; Andrew Souvall, Minority Director of Communications, Outreach and Member Services.

Mr. Latta. Well, good morning. I would like to welcome you all to our Subcommittee Meeting of the Digital Commerce and Consumer Protection this morning. I really appreciate our witnesses being here. We are going to have members coming in. There is a meeting going on downstairs and so more folks will be coming in. We see a couple more coming in right now. But I really again appreciate you so for being here, and to get started I would like to recognize myself for 5 minutes for an opening statement.

Again, good morning. And last month, this subcommittee examined how automakers and other entities are testing self-driving vehicles and preparing for the development of this lifesaving technology. While projections for the development of self-driving vehicles remains years out, advanced driver assistance systems that offer self semi-autonomous driving capabilities are entering the marketplace today.

Advanced driver assistance systems are crash avoidance technologies that can protect drivers, reduce crashes, and enhance the convenience of driving. Forward collision warning, blind spot detection, and lane departure warnings are examples of advanced driver assistance systems. These systems help drivers make safer decisions on the road by providing real-time information about surrounding roadway activity. The driver can receive this information through audible tones, steering wheel vibrations, or small flashing lights on side mirrors alerting the

driver of potential safety hazards on the road.

Increasingly, advanced driver assistance systems now entering the market are capable of taking a more active role in the driving task. Innovative systems such as automatic emergency braking and lane departure prevention can temporarily take control over parts of the vehicle's critical safety functions such as braking or steering. This can occur by the system either applying the brakes without input from the driver or steering the vehicle back into marked lanes following unintended drifting.

Automakers and equipment suppliers have announced additional innovative driver assistance systems that are currently in line for deployment. Traffic jam assist can take control of a vehicle's functions in low speed, stop and go traffic. Autonomous valet parking can park itself and retrieve itself when summoned by the owner. And highway autopilot with lane changing is being developed to change lanes and pass other vehicles without the input of the human driver.

The deployment of the advanced driver assistance systems is demonstrating significant safety benefits across the country. Studies are showing that advanced driver assistance systems and crash avoidance technologies are reducing crashes, roadway injuries, and insurance claims. Advanced driver assistance systems are also an essential part in laying the groundwork for the deployment of fully self-driving vehicles.

Through technological advances by manufacturers and equipment suppliers, basic driver assistance systems are taking on more advanced capabilities that assume greater control of the vehicle's critical safety functions throughout a driving trip. The progression of these technologies is incrementally removing the human driver from the driving task and paving the way to full autonomy. To provide consistency in the development of driver assistance safety technologies, standards-setting organization SAE International developed a classification system to define six different levels of driving automation. SAE levels of automation establish the general scope of the driver assistance system and the role of the human driver in vehicles taking on increasing autonomous driving capabilities.

The levels span from a vehicle with no automation all the way to a vehicle with full automation or a fully self-driving vehicle. Last September, the National Highway Traffic Safety Administration adopted SAE's levels of automation for its own use in its Federal Automated Vehicles Policy.

As we discuss the levels of vehicle automation today, I look forward to learning more about the capabilities of advanced driver assistance systems currently on the market and how these technologies are increasing vehicle safety and protecting America's motorists. I look forward to examining how these systems are informing the development of fully self-driving

vehicles and how the auto industry is working to make these systems available across all models and fleets.

I also look forward to hearing from witnesses about how consumers are adopting these technologies and how they are helping to build consumers' confidence in automated driving systems. And with that I will end my opening statement. I would like to recognize for 5 minutes the gentlelady from Illinois, the ranking member, for 5 minutes.

[The opening statement of Mr. Latta follows:]

**********COMMITTEE INSERT 1**********

Mr. Latta. Good morning.

Ms. Schakowsky. Good morning and thank you, Mr. Chairman and our witnesses. Today's hearing continues our subcommittee's series on autonomous vehicles. In last month's hearing, several of our witnesses referenced different levels of automation and today we will better define those levels and we will also ask about the effectiveness of existing safety technologies.

Self-driving cars are part of a long-term vision to minimize accidents due to human error. Automated features are becoming increasingly common in our cars, but we still have a long way to go to reach full automation, Level 5, as SAE would call it. Technology must be sufficiently tested and ensure that we don't replace human error with system error. In addition, the Takata and Volkswagen scandals raised serious questions about how much we can trust industry to do the right thing on safety.

Volkswagen ordered its supplier to write software to cheat on emissions testing. With software increasingly integral to our vehicles, proper oversight becomes that much more challenging. Ultimately, the success of autonomous features and self-driving cars relies on consumers trusting the technology. Trust must be earned. Once technologies are put in new vehicles it takes decades for technology to become widespread among all vehicles on the road.

Just look at backup cameras. I worked to require backup

cameras after I met and talked to parents who were devastated after their children were injured or killed in backover accidents. We passed that law in 2008. Parents and advocates came to D.C. regularly during the rulemaking process, and NHTSA finally established the standard in 2014. And backup cameras will now be required in all vehicles starting in model year 2018, 10 years after the bill passed. It will still be years before the passenger vehicles without backup cameras cycle out of use. A car sold today may be on the road for another 2 decades. That is why it is critical we look not only at safety improvements in the long term, but also at which technologies can be effectively deployed right now to save lives.

A lot of safety technologies are out there. However, some are more effective than others. Automatic braking for instance has proven very effective in reducing accidents. The evidence on lane departures systems is more mixed. Today we will hear from the suppliers that develop safety technologies. We will hear about the testing data that is essential to lawmakers as we consider what should be standard, and we will learn about classifying levels of automation, a useful framework as we think about how we move from today's cars to the self-driving cars of the future.

It is a long road ahead, but as I have seen in my years on the subcommittee we have to push forward at every step in the

process to make safety improvements a reality. I thank all of our witnesses for being here today, and I look forward to your testimony. And now I would like to yield the remaining time to Representative Matsui.

[The statement of Ms. Schakowsky follows:]

**********COMMITTEE INSERT 2**********

Ms. Matsui. Thank you very much, Ranking Member Schakowsky. Innovation and AV vehicle technology is moving at an ever-accelerating pace. We are seeing major investments from traditional auto manufacturers, suppliers like our witnesses from Bosch and Continental, and new entrants like technology companies and ride-sharing platforms. I believe we will make big leaps forward in this space sooner than any of us would have anticipated.

Different companies are pursuing different levels of automation and we know that they do not need to move sequentially through each level of automation. Some companies are choosing to incorporate certain individual features of automation while others are investing in a more integrated Level 4 automation systems today.

In my district in Sacramento we are looking aggressively to the future to lay the foundation for fully autonomous vehicles to be tested on our roads. We are rapidly moving towards a time when truly driverless cars will be on our roads and will coexist with human drivers and other vehicles with different levels of automation.

I look forward to hearing more from our witnesses today and working with all of you to accelerate the testing and deployment of this exciting technology which holds so much promise for improving safety on our roads. I thank you and I yield back.

[The statement of Ms. Matsui follows:]

**********COMMITTEE INSERT 3**********

Ms. Schakowsky. And I yield back.

Mr. Latta. Thank you very much. The gentlelady yields back the balance of her time, and at this time the chair recognizes the gentleman from Oregon, the chairman of the full committee, for 5 minutes for an opening statement.

The Chairman. I thank the chairman and I welcome our witnesses and look forward to your delivery of your testimony which I have read and appreciate.

Following years of declining traffic fatalities, we have seen tragically a sharp rise in vehicle related deaths over the past 2 years. According to early estimates, more than 40,000 Americans, 40,000 people lost their lives on our nation's roads last year. That marks a six percent increase from 2015. And in my own state of Oregon, 2016 was the deadliest year on the roads in more than a decade, up 20 percent from the year before.

These are sobering numbers. The development of self-driving cars could be a solution to this uptick in danger facing the driving public, the main question is how do we get there? Last month, this subcommittee examined how automakers and other entities are testing self-driving cars and that we are still years away from getting them into hands of consumers.

But that has not stopped the automotive industry from laying the foundation for a complete vehicle autonomy. Today, many cars on the market, including one that my wife owns, are equipped with

active safety features or semi-autonomous driving systems. It is pretty impressive to see them in action. These systems have the potential to keep a vehicle within its designated lane; accelerate to pass another vehicle; change lanes, brake, and park all without the input of a human driver.

These advanced driver assistance systems or crash avoidance technologies represent the building blocks to a fully self-driving car. Gradually allowing the vehicle to perform parts of the driving task absent human control means that vehicles are steadily learning how to operate alone and consumers are progressively becoming more familiar and more comfortable with automated driving systems. The advancement of driver assistance systems over the last decade, it is already demonstrating this progression as this technology is minimizing crashes, reducing injuries, and decreasing insurance claims.

In recognition of the safety benefits provided by these systems, the National Highway Traffic Safety Administration has begun to formally incorporate many of these technologies in its 5-Star safety ratings program. Today's hearing will look more closely at many of the advanced driver assistance systems and crash avoidance technologies that are on the road. Our witnesses will also help us to understand the different levels of driving automation, how these technologies are improving safety, and how the development of driver assistance systems and technologies is

paving the way for fully self-driving cars.

We often say the development of self-driving cars is a lifesaving endeavor. Following a devastating year on our nation's roads this could not be any more true. I look forward to a thoughtful and engaging discussion on the levels of driving automation and how advanced driver assistance systems can lead us to the future of a full vehicle autonomy on our road systems.

So thanks for the work you all are doing, thanks for sharing your comments with us. We want to make sure to advance this innovation and technology and save lives on our roads and in our communities. With that Mr. Chairman, I don't know if anybody else on our side, I would yield to the gentleman from Mississippi for the remainder of my time.

[The statement of The Chairman follows:]

**********COMMITTEE INSERT 4**********

Mr. Harper. Thank you, Mr. Chairman. Thank you, Chairman Latta, for calling this hearing today to continue the subcommittee's efforts to explore the world of self-driving cars. As I have mentioned at our previous hearings, this topic is of particular interest to me because of the potential opportunities that self-driving cars would provide to Americans with disabilities, including those with intellectual disabilities.

In the disability community lack of transportation is widely viewed as the top impediment to advancement and success in society. Self-driving cars could offer the disability community a new method of transportation to potentially remove this roadblock and provide them additional independence that would open the doors to access new job markets and opportunities to have an even more active role in our society, which benefits us all.

I am looking forward to learning more about the capabilities of advanced driver assistance systems and crash avoidance technologies that are currently on the market and how these capabilities will advance the future of self-driving cars. And with that I yield back.

[The statement of Mr. Harper follows:]

**********COMMITTEE INSERT 5**********

Mr. Latta. Thank you. The gentleman yields back and the chair now recognizes for a 5-minute opening statement, the gentleman from New Jersey, the ranking member of the full committee.

Mr. Pallone. Thank you, Chairman Latta. Today's hearing gives us a our first true opportunity to talk about what is happening now in automated technology. While learning about the potential technologies of the future is exciting, understanding that there are products currently available that are saving lives and reducing injuries is paramount.

For the foreseeable future, human drivers are going to be driving vehicles on our roads and so efforts to prevent crashes or protect drivers and passengers in a crash are vital. For example, advances such as the addition of airbags and electronic stability control to our cars have saved thousands of lives. As I mentioned at this subcommittee's November hearing on self-driving cars, we see technologies in today's marketplace such as automatic braking that have enormous benefits.

So today I urge all automakers to expedite the deployment of these braking systems into all new vehicles. According to the Highway Loss Data Institute it takes 25 years for a new feature to be on 95 percent of cars on our roads. Therefore, when we see something that works we need to get it on vehicles quickly and it needs to be made standard on all models and makes, not just

the most expensive ones.

Witnesses today will discuss other advances such as in lighting and blind spot detection that have promise, and I hope these technologies can help prevent injuries and fatalities. And as with automatic braking, I encourage rapid deployment of any new features that are proven to be beneficial. I also look forward to hearing about research into pedestrian and bicycle rider safety. As we learned at last week's hearing on smart communities, the number of people living in urban areas is rising and those areas have unique transportation challenges.

I am also interested in hearing what new technologies can reduce injuries to rear seat passengers. While injuries to drivers are still the most common, often our most vulnerable passengers are in the back. Unfortunately, data on back seat passengers is still limited which hampers efforts to determine the effectiveness of features intended to protect them.

Therefore, I encourage NHTSA and all other stakeholders to collect and share all relevant data on road safety. We need to be able to see transit opportunities for safety improvements for people riding in the back seats as well as drivers, front seat passengers, and others on the road. More information will also encourage innovation of new safety technologies.

And finally, I will close by continuing my push for security by design and privacy by design where security and privacy are

not afterthoughts but built into the products from day 1. I don't think anybody else wants my time, so I will yield back, Mr. Chairman.

[The statement of Mr. Pallone follows:]

**********COMMITTEE INSERT 6**********

Mr. Latta. Thank you. The gentleman yields back and that will conclude our opening statements from our members. The chair would like to remind members that pursuant to committee rules all members' opening statements will be made part of the record.

At this time I also want to again thank our witnesses for being with us today. We really appreciate their taking the time to testify before the subcommittee. Today's witnesses will have the opportunity to give opening statements followed by a round of questions from our members. Our witness panel for today's hearing will include Mr. Jeff Klei, president of Continental Automotive Systems North America at Continental AG; Mr. Bill Gouse, director of Federal Programs at SAE International; Mr. David Zuby, executive vice president and chief research officer at Insurance Institute for Highway Safety; and Dr. Kay Stepper, vice president for Automated Driving and Driver Assistance Systems at Robert Bosch.

We appreciate you all being here with us today and I would like to just mention that we have another subcommittee so we have members coming and out from both subcommittees today. But we look forward to your opening statements and, Mr. Klei, you are recognized for 5 minutes.

STATEMENTS OF JEFF KLEI, PRESIDENT OF CONTINENTAL AUTOMOTIVE SYSTEMS; S. WILLIAM GOUSE, DIRECTOR OF FEDERAL PROGRAMS, SAE INTERNATIONAL; DAVID S. ZUBY, EXECUTIVE VICE PRESIDENT AND CHIEF RESEARCH OFFICER, INSURANCE INSTITUTE FOR HIGHWAY SAFETY; AND, KAY STEPPER, VICE PRESIDENT FOR AUTOMATED DRIVING AND DRIVER ASSISTANCE SYSTEMS, ROBERT BOSCH LLC

STATEMENT OF JEFF KLEI

Mr. Klei. Thank you very much and good morning, Chairman Latta, Ranking Member Schakowsky, and members of the Subcommittee on Digital Commerce and Consumer Protection. I thank the committee for the opportunity to testify today on behalf of Continental. My name is Jeff Klei and I am the president of Continental Automotive Systems in North America.

Continental is a leading tier 1 supplier to develop safe, sustainable, and affordable mobility technology and solutions for our customers. In 2016, we generated more than $43 billion in sales within our automotive tire and specialty rubber groups. Continental employs more than 20,000 employees in the U.S. in more than 80 facilities located in 26 states and has more than 220,000 employees in 55 countries worldwide.

In 2015, there were more than 35,000 lives lost in the U.S. due to traffic crashes. Projections for 2016 are the dismal increase to more than 40,000 fatalities, a level we haven't seen

in a decade. More troubling is that on a global scale, roughly 1.2 million people die in roadway crashes and another 50 million are injured each year. This is unacceptable and changing this is what motivates each and every employee at Continental.

In the last 45 years, the U.S. has experienced a relatively declining trend in traffic fatalities due in large part to vehicle safety technology like seatbelts in the '70s, the introduction of anti-lock brake systems and airbags in the '80s, and finally electronic stability control in the '90s. As the auto industry moves towards more widespread implementation of advanced driver assistance systems, Continental projects these technologies will once again reverse the recent increase in fatalities.

Continental and our dedicated employees are committed to developing safe and dynamic driving technologies that contribute to what we call our Vision Zero, a future with zero traffic fatalities, zero injuries, and ultimately zero accidents. Such a future can only be achieved with the help of innovative active and passive safety, advanced driver assistance systems, and automated driving technologies.

With building block technologies like automatic emergency braking, adaptive cruise control, and rear backup assist that are available in vehicles today, we believe we can continue to pursue our Vision Zero and achieve higher levels of automated driving. When we ultimately achieve fully automated driving we believe that

we can reduce the number of fatalities by more than 90 percent, the percentage of accidents caused by human error.

The world and the behavior of drivers within it are ever-changing and the vehicles must adapt to these changing trends. Our children seem to rely more on smart phones to stay connected with one another and living in a world of distractions has been commonplace. Automotive technology must develop accordingly.

That is why Continental has put a great deal of effort into human-machine interface technology. We want the driver to be aware of their surroundings, be aware of what systems in the vehicle are doing, and be aware of when it is safe to relinquish control of the vehicle and when it is necessary to re-engage with the vehicle. In addition, we are heavily focused on securing the systems of the vehicle with cybersecurity enhancements as well as the redundancy of safety systems.

Since 2011, we have continued a pursuit of developing and testing highly automated driving with next generation technologies like automated parking, Cruising Chauffeur, and a complete self-driving vehicle in combination with V2X technology. We were the first supplier in the U.S. to be awarded a testing license in the state of Nevada for automated vehicles and are currently testing our third generation automated vehicle on highways and roads throughout the country and around the world.

But our continued efforts in this direction would benefit greatly from an investment in infrastructure that promotes vehicle to X communication, a dedicated spectrum communication band that can be utilized by current and future safety systems, and harmonization of safety laws that allows for the full real world testing of these technologies. The safe commercial deployment of potential lifesaving technology depends on the ability to extensively test on public roads under all conditions.

Finally, we need an update of federal motor vehicle safety standards to accommodate automated driving technology in a legal framework that supports a new system of mobility. The world of mobility has the capability of expanding to unimaginable independence and personal freedom while enhancing the safety of future generations. Continental stands at the ready alongside our industry colleagues to work with the committee and Congress in helping construct laws and regulations that foster innovation, enable mobility, and create a safer environment for our public.

Thank you again, Chairman Latta, Ranking Member Schakowsky, members of the Subcommittee in Digital Commerce and Consumer Protection, and staff for the opportunity to testify at today's hearing.

[The prepared statement of Jeff Klei follows:]

**********INSERT 7**********

Mr. Latta. Well, thank you very much for your testimony today and the chair recognizes Mr. Gouse for 5 minutes. Thanks again for being here.

STATEMENT OF S. WILLIAM GOUSE

Mr. Gouse. Thank you, Chairman Latta, Ranking Member Schakowsky, and distinguished members of the subcommittee. SAE International thanks you for the opportunity to participate in this hearing, Self-Driving Cars: Levels of Automation. SAE International is a global society founded in 1905 with more than 140,000 engineers, scientists, related technical experts, and students in over a hundred countries in the aerospace, automotive, motorcycle, commercial, construction, agricultural, and specialized vehicle industries.

Some notable members were aviation and automotive pioneers Orville Wright, Henry Ford, Amelia Earhart and Ransom Olds, motor sports legends such as Andy Granatelli and Dan Gurney, along with celebrities like Jay Leno. SAE members from government, academia, and industry have testified at this subcommittee or at previous hearings in both chambers. All four of us on this panel today testifying are SAE members, as I see are many of my colleagues in the audience.

My SAE experience began even before I was a freshman mechanical engineering student at Georgia Tech when my professor and SAE Student Chapter advisor Professor Williams signed me up as a student member and gave me this membership pin. My initial exposure to SAE was before college because my father was or

actually still is an SAE member.

SAE's core competencies are voluntary consensus standards development with nearly 30,000 experts across the globe contributing to a continually growing standards portfolio of over 10,000 active and 25,000 historical standards. These are used to increase safety, performance, quality and productivity of personal commercial transportation services while optimizing cost of products and product life cycles. This is an important point as this standard I will discuss in more detail in a moment is a product, as all standards are, of our members and other volunteers' efforts.

In addition to the standards activities SAE holds dozen of conferences and symposia, including the government industry meeting held in January in conjunction with the Washington Auto Show Mobility Talks, and next week is the SAE World Congress in Detroit where my colleagues are also presenting and participating. These events plus other mutually beneficial government/industry academic networking opportunities provide information for the formation of sound public policy positions and affiliated programs, products, and services that add value and encourage innovation.

SAE standards are referenced in government regulations, procurement documents, recommendations, and guidelines issued by the U.S. DOT, the U.S. EPA, Department of Energy, the NTSB, in

regulations in our states, commonwealths, inhabited territories, and local jurisdictions. In addition, SAE standards are used internationally, Canada, elsewhere in the Americas, overseas, and by the UNECE.

SAE believes that incorporating voluntary consensus standards by reference as directed in the National Technology Transfer Advancement Act and the Office of Management and Budget Circular-A119 improves the efficiency and effectiveness of government, whether a federal, state, municipal body, or global harmonization activity, it saves time and money while increasing the efficacy of policy, legislation, and/or regulation. This is critical in order to respond to the policy or regulatory needs brought about by the rapid technology developments we are witnessing.

These developments are progressing significantly faster, potentially orders of magnitude faster, than the regulatory process. In addition, the competitiveness of products and services increased in the global marketplace because of the higher quality, value, and customer confidence achieved through conformity with SAE standards. SAE has several standards published and many documents in development by a variety of car, motorcycle, pedestrian, and truck and bus committees relating to increasing the safety and efficiency of transport.

While work continues to improve passive safety and

crashworthiness of vehicles, the potential of implementing technological solutions to avoid or reduce the severity of crashes is a major focus of our SAE committee activities. Details of these efforts, standards and documents, and progress were submitted to the subcommittee in written testimony. In summary, they encompass active safety systems, driver assistance systems, cybersecurity, vehicle connectivity and communications, measurement and test devices, vehicle testing including safe on-road testing of automated driving systems, and specific to today's hearing, title SAE International Standard J3016: Taxonomy and Definitions for Terms Related to Automated Driving. I believe there is a flyer in front of all of you of this standard.

This recommended practice originally published in 2014 and revised last September and referenced in the Federal Automated Vehicles Policy provides stakeholders including federal, state, and local/municipal regulators, policy makers with a taxonomy describing the full range of six levels, SAE 0 through 5, of driving automation in on-road motor vehicles. These six levels span from no automation to full automation. I want to point out the key distinction. You see a dark green break in the handout here is between Level 2 where the human driver performs part of the dynamic driving task and Level 3 where the automated driving system performs the entire dynamic driving task under various conditions. The document, J3016, also contains

functional definitions for advanced levels of driving automation and over a dozen related terms and definitions.

Additional terms and definitions of active safety systems are contained in another standard, J3063 that was published in November of 2015. Importantly, what these standards do not provide are specifications or otherwise imposed requirements on driving automation systems or active safety systems, nor does it imply any particular order of market introduction or adoption. One vehicle might have multiple driving automation features such that it could operate at or different levels depending upon the features that are engaged or other consideration.

Standardizing levels of driving automation and supporting terms serve several purposes particularly clarifying the role of the human driver, if any, during driving automation system engagement; providing a useful framework for driving automation specifications and technical requirements; providing clarity, consistency, and stability in communications on the topic of driving automation, as well as a useful shorthand that saves considerable effort and time. The document is designed to be useful to many beyond the engineering community, such as legislators, regulators, others in the legal profession, the general and trade media, and consumers and the public that are buying, riding in, or having freight delivered in a vehicle with some level of driver assistance or automation.

The levels I will go through very briefly are 0, with no automation; 1, a driver assistance system to a specific mode such as keeping steering or accelerating/decelerating; Level 2, partial automation, one or more driver assistance systems, both steering and acceleration/deceleration using information about the driving environment. The human driver is still expected to perform all remaining aspects.

That break down to automated driving systems that monitor the driving environment for Level 3 conditional automation, driving mode-specific performed by an automated driving system in all aspects of the dynamic driving task which define the standard, with the expectation that the human driver will respond appropriately with a request to intervene; 4, high automation, the driving mode-specific performance by an automated driving system of all aspects of the driving task even if a human driver does not respond appropriately to a request to intervene; and 5, full automation, full-time performance by an automated driving system of all aspects of the dynamic driving task under all roadway and environmental conditions that can be managed by a human driver.

SAE has been and will continue to work with organizations and entities to reference SAE standards as we learn of their policy, regulatory, and legislative activities regarding both the public on-road testing, and the deployment of vehicles with driver

assistance and automation systems. We are members of the Commonwealth of Pennsylvania --

Mr. Latta. Pardon me, Mr. Gouse, if you could just wrap up, please.

Mr. Gouse. All right. We are members of the Pennsylvania Department of Transportation Task Force; we work with the associated motor vehicle manufacturers and other groups. SAE levels of automation were adopted in the Declaration of Amsterdam and they are used as we spoke earlier of the U.S. DOT and the Federal Automated Vehicles Policy. Prior to this, the government used separate terms and retired their classification so now we have this consistent usage.

Driving assistance and automated driving systems have the potential to provide substantial benefits to all customers of road transport. And I thank you very much for this opportunity to provide this statement and answer any questions.

[The prepared statement of S. William Gouse follows:]

**********INSERT 8**********

Mr. Latta. Well, thank you very much. And Mr. Zuby you are recognized for 5 minutes and thank you very much for being here.

STATEMENT OF DAVID S. ZUBY

Mr. Zuby. Good morning, Chairman Latta, Ranking Member Schakowsky, and distinguished members of the subcommittee. On behalf of the Insurance Institute for Highway Safety, thank you for the opportunity to testify today on vehicle automation and crash avoidance technologies.

The Insurance Institute for Highway Safety and its sister organization, the Highway Loss Data Institute, are nonprofit research institutes that identify ways to reduce deaths, injuries, and property damage on our highways. We are wholly supported by voluntary contributions from companies that sell automobile insurance in the United States and Canada.

The United States has made enormous progress in reducing the toll from motor vehicle crashes. The death rate per billion vehicle miles traveled is one quarter of what it was in 1973 when crash deaths peaked at 54,589. While changes in traffic laws and their enforcement combined with changes in road and vehicle designs all contributed to that decline, our research has shown that improvements in vehicle safety have been the largest contributor to road safety since the 1990s. We are convinced that further improvement in vehicle safety will remain an important strategy to make travel on U.S. roads even more safe in the future.

Past improvements in vehicle safety largely focused on

mitigating and preventing injuries when crashes occurred. The newest tool in the vehicle safety toolbox is automation of the vehicle controls that can prevent crashes in the first place and reduce the severity of those that aren't prevented. Electronic stability control which helps prevent sideways skidding and loss of control, reduces the risk of a fatal single vehicle crash by 49 percent and cuts the risk of a fatal multiple vehicle crash by 20 percent.

More recently, front crash prevention systems which help drivers avoid front to rear crashes with warnings or automatic braking reduce these crashes by 26 percent for warnings by itself and by 50 percent for warnings combined with auto braking. Reductions for crashes with injuries are even larger.

These are large reductions and count as wins for automation of vehicle control, but neither ESC nor front crash prevention systems prevent all the crashes they target. In addition, there are other new crash avoidance technologies like those that aim to prevent crashes precipitated by inadvertent lane drifts for which we have not yet found definitive benefits. There are reasons to be skeptical of the claims that driving automation will eliminate all crashes currently caused by human error. This is especially true in the near term technologies which will continue to involve human driver to a large extent.

The design of these technologies and how drivers interact

with them will be an important factor in their success. For example, we have found that on average across multiple implementations from various automakers, lane departure warning and other lane maintenance systems are used by only 50 percent of drivers whose cars have them. There is a wide variation in the use rate and that seems to be influenced by system design.

As technology allows further automation of the driving task, we are concerned that some human drivers will fail to understand the limitations of these systems on their vehicles and crash because they are overly reliant on them. The design of driving automation systems will be key to helping drivers understand how systems work including the limitations of the technology. It will be important to continually monitor the effects of safety on new technologies entering the market.

The studies mentioned above were only possible with close cooperation of a few automakers who helped us identify by vehicle identification number the specific vehicles that were equipped with a range of optional features. Unfortunately, there was no comprehensive database linking VINs to information about what features are present on a given vehicle. Government policies aimed at ensuring the availability of such highway safety data are important to enhance highway safety research on the effectiveness of these emerging technologies.

Thank you again to the members of the subcommittee for

inviting me to share what IIHS and HLDI have learned about the effectiveness of crash avoidance technologies. I would be happy to answer any questions.

[The prepared statement of David S. Zuby follows:]

**********INSERT 9**********

Mr. Latta. Well, thank you very much. And Dr. Stepper, you are recognized for 5 minutes for your opening remarks. Thank you very much for being here.

STATEMENT OF KAY STEPPER

Mr. Stepper. Thank you Chairman Latta, Ranking Member Schakowsky, and members of the committee for the opportunity to testify before you today. My name is Kay Stepper, vice president with responsibility for the Driver Assistance and Automated Driving Systems for Bosch in the United States. At Bosch we are proud to be inventive for life and I am honored to discuss an issue that is one of the pillars of our everyday work at Bosch, to save lives.

Bosch has a long history in the United States. Robert Bosch himself established the first office in the United States in New York City in 1906. Now in 2017, Bosch companies operate more than 100 sites across the country. Bosch believes that automated driving is the future of mobility, and leading the way to safe, agile, and automated driving is our guiding principle. Worldwide, Bosch has more than 2,500 engineers and researchers working on the topics of automated driving and advanced driver assistance in our autonomous driving tests that is conducted in the United States, Germany, Japan, and Australia.

Preliminary 2016 data from the National Safety Council projects that as many as 40,000 people died in motor vehicle crashes last year. The magnitude of the safety crisis is such that we must seek active means to increase deployment of

technologies that can support drivers and reduce accidents and injury rates. Driver assistance systems such as automatic emergency braking and blind spot detection can assist in reducing the rising fatality and injury numbers that we are facing in the United States today.

In the near term, it is critical that government and industry continue to work together to help increase consumer access to and understanding of these advanced technologies. I commend the committee for calling this hearing and for focusing its attention on two topics that lie at the heart of this transformation in vehicle mobility: the levels of automation and the importance of the deployment of driver assistance systems as a foundation for automated driving. Unfortunately, these topics are often overlooked in the overall dialogue about automated driving. The truth is that many drivers and passengers are already experiencing the benefits of vehicle automation every single day. The active safety system electronic stability control is integrated into every new light-duty vehicle sold in the United States today. This revolutionary technology invented by Bosch engineer Dr. Anton van Zanten has saved thousands of lives. A 2014 report from NHTSA found that ESC saved close to 4,000 lives during the 5-year period from 2008 to 2012.

Automated driving will bring great benefits and pave the paths forward a new vision of personal and collective

transportation. However, it will take time to achieve fully automated driving and it will be an evolutionary process, building up on the stepping stones of active safety, driver assistance, and crash avoidance system.

In discussing the evolution toward automated driving I want to emphasis that Bosch strongly supports NHTSA's decision to adopt the SAE J3016 framework for levels of automation as part of the Federal Automated Vehicle Policy. This is a major step toward harmonizing and establishing a common set of definitions across the various stakeholders involved in these efforts. Bosch wishes to highlight automatic emergency braking as one clear example of how drivers are being introduced to automation in a gradual manner, and also of how automation intervention by the vehicle can provide the greatest benefit in terms of accident reduction.

Suppliers play an important role in the innovation cycle and many suppliers such as Bosch conduct extensive testing in the lab on test tracks and on public roads. Suppliers presently face several obstacles in carrying out this testing on public roads, and we respectfully request that the committee consider extending the FAST Act exemption to include suppliers with active and established research and development programs in the United States.

Bosch position on the need for improved consumer education is well known. We have urged NHTSA and the U.S. Department of

Transportation for many years to include crash avoidance system as a key component of the vehicle 5-Star rating and to provide additional information to consumers through the Monroney label. Bosch believes that displaying crash avoidance systems as part of the official safety portion of the Monroney label and particular in the form of 5-Star rating, as the most effective means to help driver consumer awareness and eventually consumer demand for such technologies. Without the clear presence of crash avoidance and mitigation technologies on the most recognizable feature for consumers, the physical Monroney label as affixed to the vehicle, consumer education will continue to lag.

The adaption of crash avoidance technologies into NCAP would be a very significant improvement and one which we believe will bring about immediate benefits as well as paving the path toward the attainment of automated driving in the future. Bosch encourages Congress and NHTSA to cooperate a path forward for the U.S. NCAP to become an effective means of encouraging the enhanced adoption of these lifesaving systems. Bosch truly believes that a 5-Star rating is the most effective means to translate the presence and performance of crash avoidance technologies into an easy-to-understand indicator for consumers.

Thank you again for the opportunity to speak before the committee. I welcome any questions you may have.

[The prepared statement of Kay Stepper follows:]

**********INSERT 10**********

Mr. Latta. Well, thank you very much for your testimony and that will conclude our opening statements from our witnesses. Again we appreciate you being here, and I will begin the questions if I may.

And if I could, Mr. Zuby, I would like to just follow up what you said what you said. A lot of the drivers out there driving the vehicles that have a lot of this technology are not using it. Is it because, you know, is it too difficult for them to understand maybe from reading the instructions in the manual or they just don't want to bother with doing it, or what are you finding out there why people aren't using that technology?

Mr. Zuby. Right. So we think that one of the reasons that people aren't using lane departure warning technology is because they find it annoying. The way that technology works today is that it basically gives you a warning which may be an audible beeping or a vibrating of the steering wheel or vibrating of the seat when you transgress a lane line without signaling your intention to do so.

So one way to think of the current technology is it is sort of a turn signal nanny rather than warning the driver about an imminent danger. And when we interview, or rather survey drivers with the technology that is one of the things that they tell us is the lane departure warning is very annoying. Systems that interact with the driver less frequently like front crash

prevention are much more likely to be left turned on. In the studies that we have done we find that AEB and front crash warnings are left on in 90 percent or more of the vehicles, whereas we only see about 50 percent of lane departure systems left on.

The other thing that our research is finding is that the design of the lane departure warning seems to have an influence. So people don't like the audible alerts, but when the system alerts them about crossing the lane line with a vibrating steering wheel or a vibrating seat they are much more likely to leave it on. And we also find that if the car takes some steering action in response to, you know, transgressing the line that too leads to higher use rates than the original systems which only warned the driver with an audible warning.

Mr. Latta. Well, thank you very much.

Mr. Klei, if I could ask you a little bit about especially on the cyber side, in your testimony you mentioned how driver assistance systems will require sensors to gather data about a vehicle's surrounding environment in order to adequately assist that driver. How is Continental thinking about the privacy and security of the advanced driver assistance systems and crash avoidance systems, and what is Continental doing to secure those systems against cyber threats?

Mr. Klei. Thanks for the question, Chairman Latta, and it is a great question and it is something that at Continental we

have been thinking about for many years. Cybersecurity is not new with automated driving or the advanced driver assistance systems. It has been a discussion point and a key development area for us for many, many years ever since, really, electronics started to come into the car. I would say the connection to the cloud, the connection with all the 4G connections that are now available open up a new opportunity for those cybersecurity threats. We have developed an entire competency center in our company that is used extensively for cybersecurity and we are trying to install all the different protections that we can from known cybersecurity attacks.

But many people say should we have a cybersecurity specification it is dynamic. Every day there is new threats. Every day there is new opportunities that emerge. So we have to work together with our OEM partners, suppliers, and the government to look at ways we can work together to identify and eliminate those cybersecurity attacks. But we clearly have a competency center, we think very much about it, and it is clearly a challenge as we bring many of these technologies into market. But it is not new. It has been thought about and developed for many, many years.

Mr. Latta. Well, if I could also, Dr. Stepper, would you like to comment on that on what Bosch is doing in this area on the cyber side?

Mr. Stepper. Yes. Thank you, Chairman, for the question. Bosch has been very active on this topic for cybersecurity protection. We believe very much in a layered approach, layered in a sense that there is hardware layer, software layers, and architectural layers that need to be introduced. We actually established a center of competency for cybersecurity back in 2010, and we already established additional units within Bosch that work specifically on software solution to help our OEM partners to protect against cybersecurity threats.

Mr. Latta. Well, thank you very much.

And also, Dr. Klei, could I ask a real quick question because my time is running out here, commenting on SAE levels of automation and why they are important to the industry standard of fully self-driving cars.

Mr. Klei. Certainly we very much support the adoption of the SAE standards. We think a standard that clearly defines what the levels of automation are, are very useful as we start to develop and deploy these technologies. The consumers are often confused by the various naming and the various levels. And I think we as an industry have a lot of work to do to improve that communication and education of the consumers.

Suppliers have a role in this. The OEMs have probably the largest role because they are the ultimate touch point with consumers. And then of course any assistance from the government

and other outside agencies are very, very beneficial. So we very much support it and we think everyone has a role in educating so that the naming of these technologies really describe what it can do and people don't get confused.

Mr. Latta. Well, thank you very much. And my time is expired and I will now recognize the gentlelady from Illinois, the ranking member of the subcommittee, for 5 minutes.

Ms. Schakowsky. Thank you, Mr. Chairman.

Dr. Stepper, your testimony mentions rear automatic emergency braking systems and I am wondering if you could discuss how that could help prevent backover accidents.

Mr. Stepper. Yes. Thank you, Ranking Member Schakowsky, for the question. The rear automated emergency braking is a relatively recent addition to the automatic emergency brake suite of functions that we have. We already have a mandate in the United States starting in 2018 for backover legislation to have a rearview camera installed in each and every vehicle.

So we have already a basis of the technology in there, and we also see that especially with pedestrian incidents that we see in rear backover situations this technology could really help not only to protect from material damage but saves lives and prevent injuries.

Ms. Schakowsky. And is this feature available today in any makes or models?

Mr. Stepper. It is available today but still in very, very small numbers. There are a few select vehicles in the United States today sold with this. The installation rate overall is less than five percent, in contrast to forward-looking automatic emergency braking where you look more between a 20 to 25 percent installation rate today already.

Ms. Schakowsky. You also mentioned pedestrian automatic emergency braking. Is that any different from AEB when another car is in front of the vehicle?

Mr. Stepper. It is another progression and another step in the full AEB suite. The automatic emergency braking for vehicles was invented first and brought to market. Pedestrian automatic emergency braking has a little bit of a different requirement in the sense that you need to have a very wide field of view to recognize crossing pedestrians and not only at higher speeds, but especially in urban scenarios at lower speeds. So and therefore it is different in the sense that the requirements on the technology are different and it is already part of Euro NCAP in the European Union as a requirement moving forward.

Ms. Schakowsky. Thank you. Mr. Zuby, I wonder if you have looked into these technologies and if you have any comments on that.

Mr. Zuby. Yes. We have been looking into these technologies and we have worked up a series of tests that we intend

to start using to promote the idea of reversing automatic braking. We think that that may be an additional thing that is needed to address backover crashes because the experiments that have been run using cameras show that while they definitely improve the situation and help drivers avoid running into things that are behind their vehicle that they don't expect to be behind their vehicle, they are not a hundred percent effective because the driver needs to be looking at the camera at the same time that the person or object behind them is in the view of the camera.

So automatic braking, I think, can augment the benefits that we get from the technology looking rearward in the camera during reversing maneuvers. We are also looking at pedestrian -- by the way my guys have identified, I think, 14 models of cars sold in the current model year that are equipped with reversing AEB. We are also looking at pedestrian detection. And it is a slightly more difficult problem for the technology to solve because of the field-of-view issue and the fact that pedestrians can change direction and change their movement very quickly.

Ms. Schakowsky. Because I have been so involved in the issue of the cameras and you say it is not a hundred percent, have you estimated how effective it is or how many times it does fail to prevent an accident?

Mr. Zuby. Well, so in experiments we find that it reduces the likelihood that you are going to back over something that is

in your path by about two thirds.

Ms. Schakowsky. Okay. So you have done years of research on AEB systems. Can you give us more details on how these systems work and why they save lives?

Mr. Zuby. So the current AEB systems mainly prevent front-to-rear crashes. They are effective at preventing those kinds of crashes, and even when they don't prevent the crash they reduce the risk of injury. Front-to-rear crashes don't result in a lot of fatalities. It is in the neighborhood of about 800, 900 people a year out of the nearly 40,000 die in front-to-rear crashes. So even if a technology were to prevent all of the rear crashes it would have a small dent on fatalities.

But the sensors that are needed for AEB are sensors that will be needed to address other types of crashes, you know, leverage the technology to address other kinds of crashes that do account for more fatalities.

Ms. Schakowsky. Thank you. I see I am out of time, I yield back. Thank you.

Mr. Latta. Well, thank you very much. The gentlelady yields back and the chair now recognizes the gentleman from Illinois for 5 minutes.

Mr. Kinzinger. Thank you, Mr. Chairman. Thank you all for being here and taking some time with us today. It is an important hearing on the future of self-driving cars and specifically the

opportunity to learn more about the advanced driver assistance systems that is saving lives today and it is also paving the way to fully autonomous vehicles.

Dr. Stepper, in your testimony you highlighted the importance of the SAE framework for the various stakeholders in autonomous vehicles and the lack of common language for advanced driver assistance systems. How has this lack of a voluntary standard impacted Bosch's ability to bring technology to the market?

Mr. Stepper. Thank you for the question, Congressman. Very clearly, the lack of clear language and common taxonomy has resulted in some confusion at the consumer side -- what is really my car doing with the different technologies that we have? So as Mr. Gouse has very graphically illustrated in his chart, there is well defined levels of 0 to 5 for automation, and coupled with a very active consumer education campaign we can really educate consumers what they can expect.

Is it just a warning that my vehicle will provide or is it actually an actual intervention like an active braking situation or can I take my hands and my feet off the controls and the car will drive by itself? And what we have found clearly is that the lack of such common language really has led to confusion on the consumer end, and we really commend the National Safety Council together with the University of Iowa joining the Road to Zero

campaign and actually establishing a website that is called mycardoeswhat.org to educate consumers of what is actually in their vehicles today because it can be so confusing.

Mr. Kinzinger. We should do a my-congressman-does-what. Mr. Gouse, what are the challenges to adopting a voluntary consensus standard and what efforts are underway to provide a common language for advanced driver assistance systems?

Mr. Gouse. Thank you, Congressman, for the question.

Mr. Kinzinger. Might you turn your mike on. It might not be on.

Mr. Gouse. Thank you for the question. It is an emotional question internally because it is very difficult to raise awareness that our documents even exist to a variety of stakeholders that don't traditionally know that they even use this. We were working with the American Association of Motor Vehicle Administrators and they didn't even know that the license plate geometry was our standard. So that was our beginning point. And we told them we had this document in works at the same time NHTSA had their levels of automation in works, and with differing vocabulary and differing levels it confused the issue a lot. Fortunately, NHTSA decided to adopt the SAE language, and then AAMVA and through the states that proliferated. That is one example.

The same thing is happening all over the world. For the

driver assistance systems, same thing, we have a standard that is called Active Safety Systems Terms and Definitions. It is a fairly easy read. It is not really riveting like a novel, but it is a fairly easy read and we are trying to get that language adopted too. And as you hear today, we even use different terms ourselves and I agree it is confusing.

Mr. Kinzinger. Let me add on. Are there any policies, developing policies that you are concerned with as you are seeing them right now?

Mr. Gouse. The states that are unaware or choosing not to use a common terminology and the common taxonomy, I believe, will result in a patchwork of very difficult to understand and operate in environments. This is happening now at the testing level where they are passing regulations permitting testing of various levels of automation in non-salable vehicles. So it is a concern.

Mr. Kinzinger. And then we will go with Dr. Stepper on this one. When you look at educating the public about the benefits and the limitations of various systems, especially for systems like automatic emergency braking that provides a lot of value to the customer, but the customer, the consumer may not be aware that the technology is assisting the driver -- Mr. Zuby mentioned that lane maintenance systems were only turned on in 51 percent of the vehicles that IHS observed -- how do your companies, how does your company work with the consumers to build confidence in the

technology so it is being fully utilized?

Mr. Stepper. So thank you for the question, Congressman. Clearly we work with activities like the Road to Zero and the activities from the National Safety Council as well as the University of Iowa. We work very closely with our OEM customers, for example, in joined co-marketing campaigns to educate dealers, because at the end of the day new vehicles are being bought from dealerships and consumers are being consulted by dealership personnel and that is really your first touch point of a new vehicle purchase and understanding of what this vehicle really has on board in terms of technology.

So we work very actively with several OEM customers on this topic to make tours to make joint marketing campaigns around the country to educate dealerships on this topic so they can explain what is installed on the vehicle. Again I want to emphasize an additional mention of these crash avoidance technologies. In a 5-Star rating, incorporating crash avoidance technologies could also very much help in that regard because now the dealership personnel would have the Monroney label right in front of them to help them guide the consumer through the purchase.

Mr. Kinzinger. Thank you. And I have some more questions; I will submit them for the record. Mr. Chairman, I yield back.

Mr. Latta. Thank you very much. The gentleman yields back and the chair now recognizes the gentlelady from Michigan for 5

minutes.

Mrs. Dingell. Thank you for the recognition, Mr. Chairman, and for your continued interest in the automated vehicles. As you all know it is a subject that I really care a great deal about. As I stated in the last hearing on this issue, I believe it is critical that the Congress, the administration, the industry, and safety advocates all come together on a common framework for automated vehicles. Too much is at stake and we have got to get it right. Legislation will be needed to facilitate the deployment of higher level automated vehicles, and I support raising the statutory exemption caps as an interim solution while directing NHTSA to amend existing vehicle safety standards as they relate to human operated controls. And I think a lot of people don't understand what some of the regulations are because they have been there for so long.

Great strides in vehicle automation are being made. Proud of it that a lot of it is in my district in developing safety technologies that have the potential to reduce roadway deaths, and I believe helping them get to market could have a significant impact on public safety, and I have got some questions to help the committee examine these issues.

My first questions are for Mr. Gouse of SAE, and if you could just do yes or no, please. Is it correct that SAE Levels 0 to 2 contemplate that a human driver will perform all or some aspects

of what is known as the dynamic driving task?

Mr. Gouse. Yes.

Mrs. Dingell. Is it correct that SAE Level 3 contemplates that a human driver must be in the loop and prepared to respond to a request by the vehicle to take over the dynamic driving task?

Mr. Gouse. Yes.

Mrs. Dingell. Now is it true that an SAE Level 4 vehicle is one that is capable of performing all aspects of the dynamic driving task in a given situation also known as the operational design domain?

Mr. Gouse. Yes.

Mrs. Dingell. And a Level 5 vehicle can handle all aspects of driving under all conditions?

Mr. Gouse. Yes.

Mrs. Dingell. Thank you. Now these questions are for all four witnesses. Is it true that companies like FCA, Ford, and GM in Michigan are developing and currently deploying SAE Levels 1 and 2 systems? Anyone can say yes or no.

[Chorus of yeses.]

Mrs. Dingell. Thank you. Is it true that these traditional automakers and others like Waymo are developing Level 4 systems at the same time?

Mr. Klei. Yes.

Mrs. Dingell. In other words, these companies aren't

necessarily pursuing a sequential progression through the SAE Levels to full vehicle automation; is that correct?

Mr. Klei. No.

Mrs. Dingell. That is not correct. So you think they are going 1, 2, 3, 4 or are they going from 2 to 4?

Mr. Stepper. If I may jump on this one, Congresswoman Dingell, it depends on the automaker. Some absolutely proceed along the path, Level 0, 1, 2, 3, 4, and 5; some other ones may skip Level 3. There is no common answer. But some of them that you mentioned are indeed following exactly along the path of what Mr. Gouse has presented.

Mrs. Dingell. And others are skipping. Is it true that a number of existing NHTSA safety standards require human operation of vehicle controls that may not be necessary if there is no human driver, such in Level 4 or 5?

Mr. Zuby. Yes.

Mr. Gouse. Yes.

Mrs. Dingell. Do you all have good -- I don't know if I am -- my staff wants me to keep moving. But I think people don't know that a NHTSA requirement requires a foot on a brake and it is not necessary at 4 or 5, so --

Mr. Stepper. That is correct.

Mrs. Dingell. Thank you. Should NHTSA amend existing safety standards to clarify how they apply to higher level

automated vehicles without drivers?

[Chorus of yeses.]

Mrs. Dingell. Do all of you agree on that?

Mr. Gouse. Yes.

Mrs. Dingell. Well, I am running out of time so I am going to -- I have lots of questions but, and for the record I may submit some more, Mr. Chairman. But I want to commend the chairman for holding this important hearing to help educate members on the issues because it is really important that we get it right. Automated vehicles are going to be developed and they are going to be developed internationally if we don't take the lead on making sure we do it, develop them here and that these technologies are developed in the United States of America. So I look forward to working with my colleagues on both sides of the aisle in a bipartisan manner to achieve this goal.

Thank you all for being here today. Thank you, Mr. Chairman. I yield back my 15 seconds.

Mr. Latta. Thank you very much. The gentlelady yields back the balance of her time and the chair now recognizes for 5 minutes the gentleman from Mississippi, the vice chairman of the subcommittee.

Mr. Harper. Thank you, Mr. Chairman. And again thanks to each of you. This is, you know, it is just mind boggling the possibilities and we have just barely scratched the surface.

And, you know, I can't imagine what it will be like we come back in 5 years and just discuss what we are doing next. I mean this is really remarkable. So thanks for the involvement that each of you and each of your companies have. And Mr. Klei, thank you very much. We are excited about the presence of the new Continental Tires facility that will be opening in Mississippi. I think that was a great decision. We are honored to have a part of your company that will be there, and I wanted to talk to you for just a minute. Obviously, the intellectual disabilities issue is important. My wife and I have a son who is 27 years old who has Fragile X syndrome. He graduated from a special program at Mississippi State University. He works Monday through Friday. My wife has to drive him every day and drop him off and pick him up. So it is something for many families this is an important issue. So are advanced driver assistance systems at a point where they are able to provide new transportation opportunities to the disabled community?

Mr. Klei. Certainly is it an important topic and thank you for the question, Congressman. It is something that I think as an industry we are working very hard and it is not just for the automated driving technologies in general. We are trying to make mobility more available and safer for all and I think the advancements in automated driving are clearly going to move that forward.

Are they ready today to take over all driving tasks for someone that can't drive today? Not necessarily; over time, absolutely. We believe when we get to Level 4 and Level 5, absolutely it is going to provide mobility for many people that today don't have that mobility. The Waymo development, their first example that they showed was someone that was blind. And that is a huge statement for the potential mobility promise for the elderly, the blind, and the -- every disabled person in the United States will have mobility and it is an important step for them, but also for society.

Mr. Harper. Well, we are excited that Continental is taking that into consideration in the development of this.

Dr. Stepper, will you also comment on that as well?

Mr. Stepper. Yes. Thank you for the question, Congressman. We are actually working very, very intensively on the aspect of human factors because as we have learned before, on some of the levels of automation the interaction of the human being is still very, very important and part of the requirement for both SAE all the way to Level 3 as we heard earlier.

So in human factors we have done a number of research for user, human-machine interaction perspective, but we have also worked in augmented reality experiences. And that is a topic I just want to make the comment that we are actually going to show a demonstration of augmented reality for automated driving. It

is an upcoming experience here on the Hill as the event that is CES on the Hill on April 5th, where all of you of course are invited to experience some of the human factors aspect and how important it is as part of the automated driving equation.

Mr. Harper. We are expecting self-driving cars to be at Level 5 tomorrow, when most drivers are not Level 5 drivers. Mr. Klei, what do you think Congress should do to facilitate this development in deployment of advanced driver assistance systems at a point where we can assist and not be, let's say, a roadblock to that development?

Mr. Klei. Thank you, Congressman, a very important question and one that I think we look at a couple different areas. One is the Federal Automated Vehicles Policy that was issued last September. While we commend the NHTSA organization and all the work that they did we think there is a lot more to do.

First of all, when it comes to that policy it really more talks about deployment rather than development, and we think development is an important part of bringing these technologies to market safely and with real world testing.

And only through an improvement in that policy can we get there. For example, the policy requires for every software change or every change that we make we have to submit a new exemption. The time to develop those and the time to get the approvals will significantly delay the implementation of this.

I think the other thing is the model state policy. To have a patchwork of state regulations is clearly hindering our ability to test and develop and ultimately commercially deploy these technologies. So there is two examples. I could go on and on about other examples, but clearly there is opportunity to work closer together between ourselves as suppliers, the OEMs, and the government to really bring these forward in a safe and effective way.

Mr. Harper. Thanks to each of you. I yield back.

Mr. Latta. Well, thank you very much. The gentleman yields back and the chair now recognizes the gentlelady from California for 5 minutes.

Ms. Matsui. Thank you very much, Mr. Chairman, and thank you very much for the witnesses for being here today. As many of you know, the FAST Act mandated that self-driving cars could be introduced into commerce solely for the purposes of testing, but only by companies that had at the time of the law's enactment already manufactured and distributed motor vehicles in the United States.

In addition, legislation has been proposed in some states that would allow only traditional car manufacturers to test and deploy AVs. Some have even speculated that NHTSA's deployment exemptions also could be limited to car manufacturers that already build and distribute motor vehicles in the United States, and I

believe we started down this path already.

But Dr. Stepper and Mr. Klei, I know that you have been working with AV components that could benefit from direct testing. What are the barriers to your companies doing testing on your own?

Mr. Klei. From the Continental side certainly we have talked a little bit about some of those barriers with the ability to test without concern for all the different state regulations. I mean, since the Federal Automated Vehicles Policy came out there has been 48 different bills in 20 states that complicate our development of these technologies. We believe that as suppliers we also need to have the ability to test and develop these. It can't be just the OEMs that in fact do certify vehicles for FMVSS. We as suppliers don't certify vehicles. We develop technologies, we work with our OEM partners to bring them in safely, but we need the ability to develop and test those ourselves, not as a certifying FMVSS body but as one that really looks to develop those.

Ms. Matsui. Certainly. Dr. Stepper?

Mr. Stepper. Congresswoman Matsui, thank you for the question. As I mentioned earlier in my testimony, suppliers play a very important role in the innovation cycle. And as a matter of fact, often innovations like electronic stability control, the required sensors like radars, video cameras, ultrasonic sensors, and many of the other active systems, for example, the braking

and the steering in the vehicle, is actually coming from the suppliers.

So we do our utmost of course to develop and test and verify these components and systems in the lab with artificial methods like modeling and simulation, but there comes the point where we suppliers need to take these technologies on the road to ensure that they are fully verified and validated before they ever go into consumers' hands. So it is really limiting our ability to test on public roads.

And we understand very clearly that the expansion of the exemption must be handled very carefully and cautiously, but we are very happy to engage actively with the committee on this point.

Ms. Matsui. Thank you. I understand that different companies are pursuing different strategies in terms of the level of automation in the vehicles they plan to deploy. And as we have been reminded, often it is human drivers that can cause and contribute to accidents with automated vehicles.

Mr. Zuby, are there particular concerns we should consider during a transition when vehicles from all different levels of automation will be on the roads?

Mr. Zuby. Yes. I think we are already seeing in studying work that Waymo are doing and other automakers that even when the automated cars are driving at a very high level of competency they often are involved in crashes caused by human drivers. And so

I think as the testing develop it is important to make sure that there are safeguards that the testing be done in safe ways and not endanger other people and the public, but it will be absolutely necessary to test these things in the real situation because that is where they need to work.

Ms. Matsui. Right. As companies continue to expand testing of autonomous vehicles, they are all gathering an enormous amount of data about these vehicles. Mr. Gouse, are there any efforts in place to standardize the data that is being collected so that we can learn best practices regardless of where the autonomous vehicles is being tested?

Mr. Gouse. Ma'am, there are very early efforts going on. You have to understand that it is a very proprietary environment. While these gentlemen are cordial here, they probably want to kill each other sometime over a product.

Ms. Matsui. I hope not.

Mr. Gouse. No, no, no. So there are discussions going underway with the associations that they belong to on this and how to collect the data and use it.

Ms. Matsui. So we are at the very early stages of that right now but it would be very helpful to have the data. So anyway I will yield back my remaining time.

Mr. Latta. Thank you very much. The gentlelady yields back and the chair now recognizes the gentleman from West Virginia for

5 minutes.

Mr. McKinley. Thank you, Mr. Chairman. And last month when we met I said then that I think this is, this whole process is probably inevitable. And as one of just two licensed engineers in Congress, I am intrigued with the problem-solving possibilities that we have with this. I am fascinated with the developments that have occurred so far in lane movement as you referred to it or the braking.

But I am a huge skeptic of driverless cars and I am not buying this one iota yet. I will go with all the others. I can see the possibilities of that. But at the last meeting I raised some questions about IV&V and everyone on the panel had no idea what we were talking about, so I ask you because you are four different people. Are you using IV&V for confirmation of the various steps that we are going through so far?

I am seeing a no all the way around again. If we send a ship to Mars or when we send a satellite into space we run through all the steps to test it for individual verification and validation and make sure that it is going to work because we don't want to rely on competitive peer pressure without having some third party validate what we are doing. And that is what we are looking for, I am going to looking for is third party, because I know companies are going to be under a lot of pressure to skip steps 2 and 3 and go right to 4 if possible or skip 1 and go to 3, whatever that

might be they are going to move that because of competitive pressures.

We talked a little bit when one of the things since that time -- because I am fascinated with this. Again it is the engineering. I know this is inevitable. How can we work with this thing to do everything but driverless? So when I have asked the question when I have been back in my district, it is wherever it is we are excited. In fact we are going to have a summit meeting about this, about driverless cars.

But when I have raised the question, would you put your 6-year-old granddaughter in the car and let her go 40 miles to meet her brother perhaps, every one of them says no. Now I know it is going to be evolutionary. They will develop more confidence with it. But when I was hearing about if something goes wrong they are going to transfer operation back over to the person in the car, what happens if it is indeed someone that is intellectually impaired or is inebriated and we have allowed them to get in that car to be able to get home and then they are turning the transportation over to them when they are doing 60 miles an hour and they say okay, driver, it is your car?

I have a series of questions about it. I am going to remain a skeptic on this. I want to follow the money. I don't understand other than insurance companies who is really going to benefit for this, but as an engineer let me skip to my last, so

ask a question of this. If when we get to steps 4 and 5, because I have designed a lot of bridges, a lot of highways, culverts, I don't know how this is functioning yet, so is there something I should be working in in my old company in engineering that starts to get ready so the cars when we are at steps 4 and 5 there is something, is there a wire in the road, is there something along the guardrail, or is this something merely sensing it? Is this all GPS driven? I need to have a lot more information before we get anywhere close to that. Because if we are designing all these roads, why aren't we taking those things into consideration now especially with this infrastructure bill that it is going to have? So with that can you tell me what should we be doing in our highways to be ready for steps 4 and 5?

Mr. Klei. In terms of the highways themselves we have to adapt to the highways, we can't expect the highways to adapt to these systems. That is why real world testing around the world has to happen.

Mr. McKinley. So in that case, Mr. Klei, is it GPS driven or is it sensing the side of the highway?

Mr. Klei. It is both. It is GPS, it is sensing.

Mr. McKinley. It goes through a tunnel, and in West Virginia where we have almost, 50 percent of the state does not have -- I lose my signal constantly and no one knows where we are. And I don't know what happens at that point, so you are going to have

to rely on a lot better control if you are going to use GPS. So if it is going to be sensing how do we do that?

Mr. Klei. Obviously, the sensory development is a key part of that. But it is not just sensing it is also GPS. It is also vehicle-to-vehicle, vehicle-to-infrastructure, DSRC, all of that coming together will unable that Level 4 and Level 5.

Mr. McKinley. Thank you very much, I have run out of my time. But you can send -- I want some engineering answers on this, not the 90 percent savings of accidents because I think it is BS. It is not going to happen just like we have had the debates here over my 7 years in Congress that if we stop using coal we would eliminate 80 percent of the asthma attacks in this country. We know that is false. So I don't want to use a technique or a topic that says we are going to save 90 percent of accidents if we adopt this, I want to have more facts. The engineer in me says I need more facts. So thank you and I yield back.

Mr. Latta. Thank you very much. The gentleman yields back and the gentleman from Texas is now recognized for 5 minutes.

Mr. Green. Thank you, Mr. Chairman, for both you and our ranking member, Ms. Schakowsky, for having the hearing today. While the technology behind autonomous vehicles continues to evolve at a rapid pace it is important that industry and Congress continue to examine safety standards to ensure consumer safety. Not all the safety innovations are willingly accepted by the

public with the history of airbags and seatbelts has shown. Continued open discussion on these new technologies are essential moving forward so that consumers can be familiar with both benefits and the limits of autonomous features. Frankly, my wife is probably the most supporter of me not being in an autonomous vehicle when I am driving. She complains all the time about my driving.

Mr. Zuby, in your testimony you state that your research has shown that the driver acceptance of technology varies. Can you tell us more about the varying level of acceptance of new technology and what can be done to increase the public's acceptance?

Mr. Zuby. Yes. For one of the things that we found for lane departure warning systems, the mode of the warning made a big difference in whether or not the drivers accepted them. When we interview drivers what we find is they complain about audible warnings being annoying. Another important aspect of lane departure warning and lane maintenance is that the systems respond to truly dangerous situations and not be perceived by the driver as simply being a nanny about use of the turn signal.

So I think the technology needs to go a ways beyond where it is today in order to sort out what are the real dangerous situations that we need to inform the driver about versus those things that might be dangerous, but a lot of drivers aren't going

to perceive them as such.

Mr. Green. Okay. At this point is it known why one warning system is so effective and another ineffective?

Mr. Zuby. One of the issues is if the warning system can be heard by other people in the vehicle drivers tend not to like it. So the vibrating steering wheels, the vibrating seats tend to have higher levels of acceptance than audible warnings themselves.

Mr. Green. Thank you. How can we better study the effectiveness of these safety claims to ensure technology is living up to its promise?

Mr. Zuby. It is super important I think that we work out ways to make sure that data about which cars have which systems and how the systems are working is available to independent researchers. Obviously, the companies who are developing the systems are going to want to make claims about their high levels of effectiveness, but I think people in government and independent evaluators need to be able to verify those claims.

Mr. Green. I would like to ask this question of the entire panel. Would enhanced government regulation on the collection of the crash data with specific regard to what autonomous technologies were in each vehicle improve both public safety and efficiency, the AV technology? I will start with Mr. Klei.

Mr. Klei. Yes. Certainly when you look at things like the

Auto ISAC, which has been developed as an industry coalition to really share data on cybersecurity, it is a good example where data sharing can really benefit. We think there is an opportunity as well to do something similar for some of the crash data and some of the activity around autonomous, automated driving vehicles. We think that the sharing is very powerful, but it needs to be the edge cases and it needs to be things that can help all of us develop and deploy these technologies.

Mr. Green. Mr. Gouse.

Mr. Gouse. In our committees, sir, there is quite a bit of sharing going on of technical information that is not proprietary to build the standards to design test specifications, test devices, and what not to build good product, so there is a quite a bit ongoing already at that level.

Mr. Green. Okay. Mr. Zuby.

Mr. Zuby. Definitely, I think regulations prescribing what kind of data needs to be saved and under what kind of circumstances and with whom that data can be shared will help all of us achieve a greater level of comfort that the technology is being developed in a safe way.

Mr. Green. Dr. Stepper.

Mr. Stepper. Definitely a yes, Congressman. Bosch has been working very adequately to actually get NHTSA more resources for data for crash reconstruction. Why, because we have used

NHTSA's NASS database for our own research in understanding how many percent of collisions with injuries and fatalities with rear-end crashes, how many drivers failed to, for example, even after they received the warning to even apply the brakes in the first place. So it is very valuable data for us for our development purposes.

Mr. Green. Okay. Thank you, Mr. Chairman. I yield back.

Mr. Latta. Thank you. The gentleman yields back and the chair now recognizes the gentleman from Florida for 5 minutes.

Mr. Bilirakis. Thank you, Mr. Chairman. I appreciate it. Dr. Stepper, some driver assistance systems on the market use audible tones, steering wheel vibrations, and flashing lights to alert the drivers to impending hazards. We are also facing high levels of driver distraction as you know. As Bosch works to develop these technologies how are you working with automakers to ensure that these technologies aren't pulling drivers' attention away from the task of driving and causing more distraction?

Mr. Stepper. Thank you, Congressman, for the question.

Mr. Bilirakis. Sure.

Mr. Stepper. We work very intensively with our OEM partners on the human factors element. For example, evaluating what is a really effective and efficient means of alerting the driver of getting the attention from the driver back? Is it audible, is

it visual, is it maybe haptic?

As Mr. Zuby has answered before what we have found is that haptic feedback is actually very, very efficient when it is related to a specific action that is wanted. For example, if there is a hazard approaching from the rear left, if your seat vibrates on the left side of the driver's seat there is a haptic feedback that alerts you that something is happening to the left of the vehicle. Or if it is intended that you are, for example, departing your road lane, the vibration of the steering wheel is directly related to something that is going on with the steering system that the driver should pay attention to.

We have formed our own group to work on human factors to specifically look at the human-machine in action and we work very intensively not only with our OEM customers but also with academia on this topic.

Mr. Bilirakis. Mr. Klei, do you want to comment on that as well?

Mr. Klei. Yes, I think similar to the Bosch development we also have a very significant investment in the human-machine interface technologies. We have been one of the leaders in displays, in clusters, and in warning systems for vehicles for many, many years. We think that is an important part of bringing these technologies to market safely.

Clearly, when it comes to the audible versus haptic, we have

done a lot of research as well. We actually have driver monitoring cameras that we are looking where the driver is seeing, or looking, where the driving task should be. And we sometimes use LED lights or other ways to try and bring the driver's attention back to the driving task. That is a big question.

As you talk about Level 3 technologies that is the biggest question and the biggest area of development is how do you get the driver disengaged and then re-engaged fast enough to resume the driving task. And I think that is a challenge for the industry. That is why you see some developing from Level 2 to Level 4, some are going to go through Level 3. But that is probably one of the biggest challenges and we are investing heavily in this area.

Mr. Bilirakis. Okay. As a follow-up, are consumers able to manually turn off these alerts or warnings or customize them to their individual preferences?

Mr. Klei. So that is really a question for the OEM to determine what they would like to do. And it happened as well with ABS and electronic stability control and the various traction control systems, the OEMs for many years could determine which could be turned on and off. So it is something that some allow, some don't. We believe that ultimately when it is proven that the safety technologies are really going to save lives that it shouldn't be turned off. It should be developed over time to be

very easy to understand, very easy to use, and will ultimately save lives.

Mr. Bilirakis. Okay. I have a question with regard to actually a follow-up on the gentleman from West Virginia. You know, as far as do you anticipate a person -- I mean we want to help a lot of the elderly, maybe physically disabled people get around. We don't have in my area, in the Tampa Bay area we really don't have a mass transit system, so this could be extremely beneficial to people getting to doctors' appointments, what have you, these automated cars.

But you anticipate them having a standard driver's license; is that correct? I mean they have to qualify for this. For example, if you have a visual disability, if you are visually impaired and you don't qualify. I am visually impaired but I qualify at this particular time. I have a standard driver's license. I don't drive at night, but you know 5 years from now who knows? Will I be able to drive one of these cars even though I am visually impaired? That is just an example there. Can I hear from one of you? What do you anticipate?

Mr. Klei. Certainly we believe like we have talked a lot about the improvements in mobility for disabled and then certainly we think these technologies will offer significant improvements here. But it takes time and it takes really more, the systems that are developed with that in mind. And that is why we are

working hard as a company with our OEM partners to make sure that these systems are developed with all considerations in mind. It is not just for the driver that has, you know, zero disabilities. It is to provide mobility for everyone. And we think there is a clear promise and they are being developed with this in mind.

Mr. Bilirakis. Anyone else?

Mr. Gouse. May I, please. We have been working with AAMVA, the American Association of Motor Vehicles Administrators, on that exact topic for both cars and trucks. And a simple example would be some states require that parallel parking is required to get your initial driver's license, but in some vehicles the vehicle itself can parallel park without the assistance, with the assistance --

Mr. Bilirakis. If you could put the mike a little closer.

Mr. Gouse. So we have been working with them trying to define what features are in place or are possibly in place in the future and they can design their driving tests and their ratings or perhaps certification levels like a commercial driving license has or something that says you can operate a Level 3 vehicle with these features, but you can't do a completely manual one. You can't drive a manual transmission anymore. So it is a complicated question, but it is being worked on.

Mr. Bilirakis. And there will be a state issue obviously as far as that is concerned. Okay, well, that is important. I

mean we have got to know that whether -- because we want to help out our constituents. But again, you know, if you have a standard driver's license you qualify. And the gentleman asked about someone that is intellectually impaired. You know, would that person qualify? More than likely they couldn't get a license. So anyway that is something we have to resolve, so I appreciate that. I have one more question if I have time. I don't have time.

Mr. Latta. Yes. If you would like to submit it in writing that would be great.

Mr. Bilirakis. Yes, I will submit it. Thank you very much. I yield back. Thank you.

Mr. Latta. Thank you very much. The gentleman yields back and the chair now recognizes the gentlelady from New York for 5 minutes.

Ms. Clarke. Thank you, Mr. Chairman, and I thank our ranking member. I thank our expert panelists for a very important and stimulating examination of autonomous cars. Some experts have raised particular concerns regarding Level 3 automation and you have discussed it here today where a vehicle can drive itself but the driver must be ready to take over at a moment's notice. There is some evidence that Level 3 may lead to an increase in traffic collisions. During recent test drives, Ford reportedly noticed that even their engineers trained to monitor autonomous vehicles had trouble staying alert at the wheel while the car was

driving. Volvo's autonomous vehicle program is skipping Level 3 altogether and planning to go straight from Level 2 to Level 4.

Mr. Zuby and Mr. Gouse, do you agree that complications of Level 3 automation are an example of why it is important to monitor autonomous technology to make sure that it is actually making driving safer?

Mr. Zuby. Yes. Thank you for the question. Absolutely, I think the important thing will be to be able to monitor these developments as they are put out into the fleet. There is a long history of human factors research that says things like Level 3 are potential problems for human monitors, and I think that is why you find some automakers and some technology developers deciding that they aren't going to mess around with Level 3.

I am not expert enough to know that Level 3 is impossible to do successfully, but definitely there is a concern that if the car is too highly capable at the dynamic driving task that the driver will discontinue his monitoring activities and not be able to resume control when it is necessary because the system is no longer capable handling a situation.

Mr. Gouse. I would just second what David said, but I would like to caveat with bear in mind that people working on this -- I am in just awed when I go to committee meetings and listen in at the experts, the level of knowledge that is behind all this

and the amount of consideration that is going on for all the aspects. Whether it be taking over control immediately or changes in weather conditions or road issues or anything at all these levels, it is very impressive the level of expertise and the care that is going into this.

Ms. Clarke. The only factor that I guess is challenging to sort of pin down is human error, right?

Mr. Gouse. Well, there are other challenges too, just like in our normal driving that we have unexpected issues that arise. The deer jumps out that you never saw before and how do you react to that? Or there is some sort of a failure in the vehicle or in the infrastructure that is unanticipated and how do you react to that? Or someone else who has not got automation or not got assistance and makes a grave error and how do you react to that?

Ms. Clarke. But the reaction is the human being, right, not necessarily the vehicle? Or is it that the vehicle would be programmed to react to the jumping deer or the change in weather conditions?

Mr. Gouse. Well, that goes back to the level of automation, whose job it is, who is it assigned and --

Ms. Clarke. So Level 3 then becomes the challenge in terms of what the standard would be for automation versus human participation.

Mr. Gouse. The expectations between Level 2 and 3, it is

a big step.

Ms. Clarke. Okay. As we have heard, semi-autonomous features can have significant safety benefits but they may also be confusing, especially to drivers who are unfamiliar with the technology or fail to use it correctly. Consumer education will be essential to ensuring that the full advantages of these technologies are realized.

Mr. Zuby, why is it so important that drivers understand that limits of semi-autonomous features and are aware of what exactly their cars can and cannot do?

Mr. Zuby. Yes, for exactly the issues that we have been discussing about Level 3. I mean it will be important for drivers to understand how close attention they need to pay to the driving situation in order to be ready to take over and wonder what situations the system is likely to hand control back to them.

But we would say that I think it is important to try to figure out how to design these things so that the limitations and the way they work is as intuitive as possible because I don't think we can rely on people to spend extra time to learn how to drive their cars. I mean how many people in this room have read their owner's manual from front to start? There is a lot of really important information in there, but I for one have not read the owner's manual from start to finish for any of the vehicles I have ever owned.

Ms. Clarke. Very well. Mr. Chairman, I yield back.

Mr. Costello. [Presiding.] Mrs. Walters.

Mrs. Walters. Thank you, Mr. Chair.

Mr. Gouse, we know that many states and localities have developed legislation aimed at regulating self-driving cars. Can you go into further detail on the state localities implementing SAE's level of driving automation into their laws?

Mr. Gouse. I am most familiar as a staff person with Pennsylvania and Michigan and California. But there are, as Jeff said earlier there is two or three dozen states and at each state or commonwealth there is an upper chamber and a lower chamber and also there may be a regulatory agency or two of them that are working in concert or in parallel paths. So there are quite a few going on.

And our members who are active are picking up things. I know New Jersey is talking about it. I heard that from a member yesterday. North Dakota is a state, I believe. So it is not our main business as SAE to monitor state activities, but we are hearing it that when -- but we want them to adopt the SAE language so there is consistency across all the states and territories.

Mrs. Walters. Yes. I think that is going to be an issue. The consistency is going to be obviously very, very important. And then the same question for you again is a number of groups have developed classification systems to define automated driving

systems, and can you discuss why SAE determined the J3016 standard to be the most optimal way of defining the different automated driving systems?

Mr. Gouse. I would just like to say probably that the committee leadership and members worked very hard on this over quite a bit of time with a tremendous amount of input from various different stakeholders. And it is not just a committee of technology developers, there are policy folks in there, NHTSA was part of it, motor carriers, Federal Motor Carriers was part of it.

So it was an ongoing process. It was in fact adopted internationally before NHTSA did even at the Amsterdam convention in April of '16, I believe. So it is becoming a global standard and it is being validated that way across the globe and in the states as being the preferred choice. It is also a living document. It has been revised already once since it was issued. In fact, the name was even changed a little bit to clarify it. So it will go through revisions and additional references to discuss some of the issues that were brought up here in questions to add to it.

Mrs. Walters. Okay, all right. Thank you very much, and I yield back the balance of my time.

Mr. Costello. Mr. Cardenas, you are now recognized for 5 minutes.

Mr. Cardenas. Thank you very much, Mr. Chairman. Something just occurred to me. Are we likely going to see in the near future -- I grew up learning how to drive on a stick shift. A lot of today most drivers in America probably don't know how to use a manual or a stick shift vehicle, these automatic gear shifting vehicles. Are we looking at possibly in the near future where people get in their car and they push a button, today I am going to use automation 1, 2, or 3 Level, and maybe that is the new gear shifting or shifting of the vehicle that we are going to be driving in the future? Does that make any sense or is that probably likely what we are going to be looking at?

Mr. Klei. I think one of the things that we look at when we are looking into development is you never take the fun away from driving your car. We still like the ability for people to drive their cars when they want to drive their cars. But there is many driving tasks, there is many opportunities for disabled to provide mobility, and that is where we think the big benefit will be. We never want to take the fun away though.

So it could be someone gets in a car and says yes, I want to go from point A to point B in an automated way or it could be that I want to drive myself on the windy country roads. So I think there is going to be some opportunities there over time for people to still have fun, but in certain circumstances still get the mobility that they need and they want and to be able to do other

things in the car.

Mr. Cardenas. Well, speaking of taking the fun away driving, I can envision if we are going to be appropriate as a government and maybe in the future what we have is we have a speed limit technology where if you are going to be driving an automated vehicle then the speed limit is 35 miles an hour. Your car is not going to be allowed to go over 35 miles an hour on that piece of the road.

Mr. Klei. Yes. I mean, I think these are things that we need to consider, but quite frankly we believe that if you do that you could actually introduce more challenges because everyone will try and go around the car. You want the car to flow naturally with traffic with other automated vehicles as well as non-automated vehicles, so you want it to be very natural, and through testing and development that is what we are developing for. So to limit a car and limit the mobility and limit the functionality is going to limit the testing and deployment of such technologies and potentially lifesaving benefits.

Mr. Cardenas. For those of you who are on the panel from private industry, I mean how do you feel about your relationship right now with federal departments when it comes to reporting and expectations of, you know, obviously non-proprietary progress and letting them know what you are looking for as long as timing of introducing products, et cetera?

Mr. Klei. I think, Congressman, it is a great question. It is one that through the Federal Automated Vehicles Policy that was rolled out last September from NHTSA it is a great start to bringing the collaboration together between industry and government. And we think it is a big step forward but there is more work to do.

In that policy it requires significant reporting between the industry and NHTSA and that reporting needs to be better defined, it needs to be more expedited, and the exemption rules that we are all looking for especially in the development side need to be improved. And so we are working closely with that agency, with NHTSA to try and improve that and make sure that when it is officially rolled out and deployed that really it is, in fact, usable and it is going to drive this technology forward and potentially save lives when deployed.

Mr. Cardenas. What country right now seems to be more, I don't want to use the word advanced, but more ready and willing to allow their constituents to drive the highest class of automated vehicle right now?

Mr. Klei. Every country has certain limitations and certain regulations and there is no one country that is easy. Every country has different --

Mr. Cardenas. I mean is there a particular country right now that -- I am thinking of Germany. I am wondering if they are

allowing a little bit more than we are so far.

Mr. Klei. I don't know that there is one country that says it is easy to do. Every country has certain limitations and for good reason.

Mr. Cardenas. Anybody know what is going on around the world?

Mr. Stepper. The same as Mr. Klei said, from my side sometimes it is not even regulated by a specific country law. You know, also in Germany, you mentioned Germany as an example, the different states have different laws and different regulations and the regards of allowing or not allowing different levels of automation. There may be some states that are really fostering the rollout so that companies like Bosch can go on public roads and test and validate the systems which is very helpful for our development to be allowed to do that.

Mr. Cardenas. Okay. Thank you, Mr. Chairman.

Mr. Costello. Mr. Mullin, you are now recognized for 5 minutes.

Mr. Mullin. Thank you, Mr. Chairman.

Doctor, is it Stepper?

Mr. Stepper. Yes.

Mr. Mullin. Thank you for being here. You talk about the technology and moving forward with the technology of going out and testing the vehicles. But can you explain a little bit more

how that works with the technology of the vehicle versus the GPS --

Mr. Stepper. Yes.

Mr. Mullin. -- that the vehicle I am assuming has to be programmed into a GPS and it has got to take you from point A to point B; is that correct?

Mr. Stepper. So it depends on the level of automation, Congressman. So if you would go all the way to a Level 5 automated driving, for example, which really takes the driver out of the loop and there is no longer a driver required to operate the machine that it would exactly the scenario that you would dial in a particular destination and the vehicle will take you there, for example, door to door.

Mr. Mullin. Well, what is Level 1?

Mr. Stepper. In Level 1, this is what we call today's driver assistance systems where there is --

Mr. Mullin. Where your seat vibrates and it tells you and does all that stuff?

Mr. Stepper. For example, there would be a warning that there is an impending front-to-rear end collision or there is a lane departure that is about to happen.

Mr. Mullin. And 2?

Mr. Stepper. 2 combines the longitudinal and lateral control of the vehicle so, for example, we still call it the

assistance functions. It is functions like a traffic jam assist where the vehicle in that particular scenario in a traffic jam would automatically take the control for the longitudinal and the lateral perspective of the vehicles but the driver is still fully responsible and fully in the loop, whereas in Level 3, for example, you take that as one example to a traffic jam pilot where you can take your hands and your feet off for a well-defined scenario.

You need to be on a Class 1 road. On a traffic jam pilot, for example, you need to have preceding traffic, and then for this stop and go traffic the machine would take over the control of the vehicle until it handles it back to the human being.

Mr. Mullin. And 5 is what we started the conversation with. Do we see the advancement of the vehicles catching up or going to surpass the GPS? Because everybody uses their road maps and their GPSs on their phones and I am sure I am not the only one that it takes me to the wrong place all the time.

Mr. Stepper. Yes, yes.

Mr. Mullin. So they would have to work simultaneously, wouldn't they?

Mr. Stepper. Yes, so they actually, Congressman, there is additional technology that is required. So what we know today as GPS, also standard definition maps, for Level 4, Level 5 automated driving to a certain extent even for Level 3, we have the need for high resolution, highly dynamic maps that really

exceed the requirements that we see from the map requirements from today's navigation system. And that is actually coupled in a process called data fusion with onboard sensing via radio cameras, your radars, your other sensing technology you may have on board on the vehicle that will recognize certain landmarks like a fire hydrant, like a bridge, like a certain exit, and it combines the GPS information --

Mr. Mullin. That is more of an eyesight on it.

Mr. Stepper. As well as non-visible electromagnetic base like radar, for example, or LiDAR technology which uses laser light.

Mr. Mullin. So would this be one entity or would each company be responsible for their own technology for the GPS to which their vehicle is going to be operating by?

Mr. Stepper. It really comes together at the end at the vehicle manufacturer. There may be different suppliers for certain sensing technologies or GPS technology. What really is the trick to have the competency in bringing all this data together in this data fusion process and derive driving policy decisions out of that.

Mr. Mullin. What I am talking about is somebody working on this end of the GPS as you guys are working up with the vehicle, are they going to meet? Or when the technology for the vehicle gets to that point, then we start diving into the precise GPS?

Mr. Stepper. Yes, so that is already available today in a system that is called differential GPS systems that increases the resolution. Most companies, actually, out there testing and validating automated driving today use differential GPS system to get them to the resolution that they need, which in essence is a centimeter resolution as opposed to a couple meters that we see today. So that technology is already available today. The challenge in the development is going to be to bring the prices down and the costs down of such an advanced GPS system for use in every vehicle.

Mr. Mullin. Is there one company that is leading that?

Mr. Stepper. There are several companies that are working on that exact topic. There is not one company that stands out.

Mr. Mullin. Do you have one particular one that you are working with?

Mr. Stepper. We work really with all of them at the moment. There is no particular one that I can point out at the moment, Congressman.

Mr. Mullin. All right, thank you. Thank you for your time. Mr. Chairman, I yield back.

Mr. Costello. Thank you. I will now recognize myself for 5 minutes and ask a question to all panelists, two-part question. One, how is the technology -- excuse me. How is the development and testing of these systems different from the development and

testing of fully self-driving technologies; and second, how much can be learned from the development and testing of advanced driver assistance systems?

Mr. Klei. So first, what is different, I don't really think there is so much difference in the way we develop and we test technologies, everything from ABS through electronic stability control and all the way to fully automated driving. It is a very rigorous, long testing process. It starts with the technology itself. It starts with bench testing, then in contained track environments, and we evolve all the way to, ultimately, the real road and real world testing.

So the process is very similar. Obviously, the conditions by which we test are going to be different depending on the technology. But in terms of the rigorous, you know, Six Sigma, continuous improvement mindset that we have to make sure the products are safe is no different regardless of what the technology is. The challenges are bigger the higher levels of automation you go to, but the testing process itself is always very much the same, safety first.

When it comes to the implementation of these and across the various product portfolio again everyone is going to be different, and ultimately it is the OEM that decides when it is safe to deploy in the vehicle. We work with OEM customers and they ultimately are the ones that certify for FMVSS.

Mr. Gouse. I would like to just briefly add a couple things. Prior to the beginning of --

Mr. Costello. Make sure your microphone is on.

Mr. Gouse. Prior to the beginning of testing there are some tools you put in place what are called a design failure mode effects analysis and failure mode effects analysis where you look at all different ways a system might fail and then you design a test procedure to encompass that and then you look at when something fails, whether it is part of the system or something external or you are testing an automated vehicle but the engine conks out or something or you get a flat tire, you have to build all of that into your test procedures. And so you have got a complete, very comprehensive and carefully designed program to execute as part of the process.

Mr. Zuby. Yes. I would agree with Mr. Klei and Mr. Gouse that the process is similar. But I think one of the things that we need to keep in mind that as we deploy increasingly evolving technologies we do need to watch them very carefully and see how they perform in the real world. And when they fail to perform try to understand whether or not they are failing to perform because of a deficiency in the technology, a deficiency in the logic behind the technology, or because the circumstance in which they failed is just outside the design domain of that particular technology.

Again, consequently, I think information about what is happening in the real world as these technologies deploy is going to be vitally important to making sure that this stuff is developed in a safe way.

Mr. Stepper. And if I just may add a few points. Number one is what we didn't have available in the past when we started developing ABS or ESP, for example stability control, was an international standard specifically designed for the different safety assessments and different safety levels. And that standard is called ISO 26262 which was specifically developed for use in the automotive space to define different safety levels and also define how to get to and what you have to meet in order to get to the different levels of this safety.

Number two, what we didn't have available when we are deploying ABS or electronic stability control or early in driver assistance is the vehicle being connected to the rest of the world, being connected to servers. If we would just proceed with conventional validation as we have in all these decades it would really be cost and time prohibitive. We would; literally, in order to fully validate a fully automated vehicle we would have to drive a distance that equals the average distance between the sun and the earth which is not feasible from a cost and time perspective.

So what we continue to deploy is the advantages of being

connected and having vehicles deployed in the field that collect for us very valuable data of real world traffic situations that we then can take back to analyze and develop and adjust our software, for example, accordingly.

Mr. Costello. Thank you. Seeing there are no further members seeking to ask questions for the first panel, I would like to thank all of our witnesses again for being here today.

Before we conclude, I would like to include the following documents to be submitted for the record by unanimous consent: a report from EMA; Advocates for Highway and Auto Safety's FAVP comments in a March 27th letter to Chairman Latta and Ms. Schakowsky; a statement from the National Safety Council; a statement from Global Automakers; a letter from the U.S. Chamber of Commerce, Technology; a statement from American Car Rental Association; a statement from Mobileye; a statement from EPIC; and a letter from Honda.

[The information follows:]

**********COMMITTEE INSERT 11**********

Mr. Costello. In pursuant to committee rules, I remind members they have 10 business days to submit additional questions for the record and I ask that witnesses submit their response within 10 business days upon receipt of the questions. Without objection, the subcommittee is adjourned.

[Whereupon, at 12:00 p.m., the subcommittee was adjourned.]