U.S. SURFACE TRANSPORTATION: TECHNOLOGY DRIVING THE FUTURE

HEARING

BEFORE THE

SUBCOMMITTEE ON RESEARCH & TECHNOLOGY

COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY

HOUSE OF REPRESENTATIVES

ONE HUNDRED FOURTEENTH CONGRESS

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June 12, 2015

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U.S. SURFACE TRANSPORTATION: TECHNOLOGY DRIVING THE FUTURE

FRIDAY, JUNE 12, 2015

HOUSE OF REPRESENTATIVES,
SUBCOMMITTEE ON RESEARCH AND TECHNOLOGY
COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY,
Washington, D.C.

The Subcommittee met, pursuant to call, at 9:09 a.m., in Room 2318 of the Rayburn House Office Building, Hon. Barbara Comstock [Chairwoman of the Subcommittee] presiding.

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House of Representatives
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Subcommittee on Research and Technology

U.S. Surface Transportation: Technology Driving the Future

Friday, June 12, 2015
9:00 a.m. to 11:00 a.m.
2318 Rayburn House Office Building

Witnesses

The Honorable Gregory D. Winfree, *Assistant Secretary for Research and Technology, United States Department of Transportation*

Dr. Michael Meyer, *Chair, Research and Technology Coordinating Committee (FHWA), National Academies' Transportation Research Board*

Dr. Brian Smith, Director, *Center for Transportation Studies, University of Virginia*

Mr. Jeffrey J. Owens, *Chief Technology Officer and Executive Vice President, Delphi Automotive*

U.S. HOUSE OF REPRESENTATIVES
COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY
SUBCOMMITTEE ON RESEARCH AND TECHNOLOGY

HEARING CHARTER

U.S. Surface Transportation: Technology Driving the Future

Friday, June 12, 2015
9:00 a.m. – 11:00 a.m.
2318 Rayburn House Office Building

Purpose

On Friday, June 12, 2015, the Research & Technology Subcommittee will hold a hearing to review surface transportation research, development, and technology (RD&T) programs and activities within the U.S. Department of Transportation (DOT), and the relationship between the Department and non-federal entities that also conduct transportation research. Spending at the DOT for RD&T is approximately $1 billion annually. The hearing will also provide the Subcommittee with the opportunity to examine how research and development conducted today can lead to the revolutionary technological applications of tomorrow. Witnesses represent a variety of stakeholders from the federal government, academia, and industry.

Witness List

- **Honorable Gregory D. Winfree**, Assistant Secretary for Research and Technology, United States Department of Transportation
- **Dr. Michael Meyer**, Chair, Research and Technology Coordinating Committee (FHWA), National Academies' Transportation Research Board
- **Dr. Brian Smith**, Director, Center for Transportation Studies, University of Virginia
- **Mr. Jeffrey J. Owens**, Chief Technology Officer and Executive Vice President, Delphi Automotive

Background

The U.S. Department of Transportation annually supports over $1 billion in RD&T activities in multi-modal surface transportation (rail, transit, motor carrier and highway). Such RD&T is conducted by a host of agencies within the DOT, including the Federal Highway Administration (FHWA), the Federal Transit Administration (FTA), the National Highway Traffic Safety Administration (NHTSA), the Federal Railroad Administration (FRA), and the Federal Motor Carrier Safety Administration (FMCSA).

According to the Congressional Research Service, funding for DOT R&D is "generally included in appropriations line items that also include non-R&D activities; therefore, it is not possible to identify precisely how much of the funding provided in appropriations laws will be allocated to R&D specifically unless funding is provided at the precise level of the request. In general, R&D funding levels are known only after DOT agencies allocate their appropriations to specific activities and report those figures."[1]

[1] http://www.crs.gov/pdfloader/R43944

However, the Federal Highway Administration (FHWA) and the Federal Aviation Administration (FAA) "account for more than three-fourths of the department's R&D funding."[2]

Provided by DOT, Figure 1 at the end of this document lists the Department's fiscal year 2016 budget request for *all* surface transportation RD&T, which total over $1.44 billion. The chart categorizes RD&T into "basic research (without specific application); applied research (for a specific need); and developmental research (design, development and improvements of prototypes and processes)" and technology as "demonstration projects and other related activities associated with research and development activities."

U.S. Department of Transportation Research, Development and Technology Activities

Office of the Assistant Secretary for Research and Technology (OST-R)

DOT research and development activities have traditionally been coordinated through the Research and Innovative Technology Administration (RITA). As part of the Omnibus Appropriations bill signed into law last year (PL 113-76 on January 17, 2014), DOT elevated all activities previously performed by RITA into a new Office of the Assistant Secretary for Research and Technology (OST-R), located within the DOT's Office of the Secretary.

While the name of the program changed, the mission remains the same. OST-R is responsible for reviewing and advocating for the Department's research, development, and technology portfolio. The FY 2016 budget requests $14.6 million for activities to be administered by the office in support of its mission to "coordinate, collaborate, and maximize the effectiveness of the Department's research, development, and technology portfolio as well as enhancing the data collection and statistical analysis programs to support data-driven decision-making across the Department."[3] OST-R oversees the following programs, which are funded out of other Administration accounts:

OST-R RD&T Funding	FY 2015 Enacted	FY 2016 Request
Intelligent Transportation Systems (FHWA)[4]	$100.0	$158.0
University Transportation Centers (FHWA)[5]	$72.5	$82.0
Bureau of Transportation Statistics (FHWA)[6]	$26.0	$29.0
Positioning, Navigation and Timing[7]	$1.6	$1.6
Research, Development and Technology Coordination[8]	$1.3	$0.5
Transportation Safety Institute*	-	-
Volpe National Transportation Systems Center*	-	-

Budget in Millions of Dollars
** Fee for Service*

[2] http://www.crs.gov/pdfloader/R43944
[3] http://www.dot.gov/sites/dot.gov/files/docs/FY2016-BudgetEstimate-OST.pdf
[4] http://www.dot.gov/sites/dot.gov/files/docs/FY2016-BudgetEstimate-FHWA.pdf
[5] http://www.dot.gov/sites/dot.gov/files/docs/FY2016-BudgetEstimate-FHWA.pdf
[6] http://www.dot.gov/sites/dot.gov/files/docs/FY2016-BudgetEstimate-FHWA.pdf
[7] http://www.dot.gov/sites/dot.gov/files/docs/FY2016-BudgetEstimate-OST.pdf
[8] http://www.dot.gov/sites/dot.gov/files/docs/FY2016-BudgetEstimate-OST.pdf

Federal Highway Administration (FHWA)[9]

The FHWA Research Technology & Education (RT&E) Program "conducts and coordinates research and development to generate innovative solutions to highway and transport challenges. It also undertakes significant technology deployment to accelerate the use of more effective decision-making information and cutting-edge practices and tools that allows our country to make the best investments in the Nation's largest utility: our transportation system."[10]

The FY 2016 budget requests $496 million for FHWA's RT&E program, which includes the following major research areas:[11]

Program Activity	FY 2015 Enacted	FY 2016 Request
Highway Research and Development	$115.0	$130.0
Technology and Innovation Deployment	$62.5	$70.0
Training & Education	$24.0	$27.0
Intelligent Transportation Systems[+]	$100.0	$158.0
University Transportation Centers[+]	$72.5	$82.0
Bureau of Transportation Statistics[+]	$26.0	$29.0

Budget in Millions of Dollars
[+] As noted above, these programs are administered by OST-R

Within the Intelligent Transportation Systems' Joint Program Office, the DOT has established an automation research program whose goal is to "enable safe, efficient, and equitable integration of automation into the transportation system."[12] The hearing will provide an opportunity for discussion of this technology from the perspective of the federal government as well as industry, represented by the witness from Delphi Automotive, a leader in automotive vehicle technology.

Federal Transit Administration (FTA)[13]

The FTA Transit Research and Training Program activities support the overarching goal of strengthening public transportation in the United States. Specifically, the program "funds applied research on innovative technology and practices in the public transportation sector, provides technical assistance to the transit industry, and supports public transportation workforce development efforts."[14] The FY 2016 budget requests $60 million for the Transit Research and Training account for the following programs:[15]

[9] $51.3billion requested for FY 2016; http://www.dot.gov/sites/dot.gov/files/docs/FY2016-BudgetEstimate-FHWA.pdf
[10] http://www.dot.gov/sites/dot.gov/files/docs/FY2016-BudgetEstimate-FHWA.pdf
[11] http://www.dot.gov/sites/dot.gov/files/docs/FY2016-BudgetEstimate-FHWA.pdf
[12] http://www.its.dot.gov/factsheets/pdf/AutomationUSDOT.pdf
[13] $18.4 billion requested for FY 2016; http://www.dot.gov/sites/dot.gov/files/docs/FY2016-BudgetEstimate-FTA.pdf
[14] http://www.dot.gov/sites/dot.gov/files/docs/FY2016-BudgetEstimate-FTA.pdf
[15] http://www.dot.gov/sites/dot.gov/files/docs/FY2016-BudgetEstimate-FTA.pdf

Program Activity	FY 2015 Enacted	FY 2016 Request
Research, Development, Demonstration and Deployment	$30.0	$26.0
Transit Cooperative Research Program	$3.0	$7.0
Technical Assistance and Training	$4.0	$7.0
Human Resources and Training	$0.5	$20.0

Budget in Millions of Dollars

National Highway Traffic Safety Administration (NHTSA)[16]

The NHTSA Vehicle Safety Research and Analysis programs support DOT safety goals "through conducting motor vehicle safety research and development on advanced vehicle safety technology, ways of improving vehicle crashworthiness and crash avoidance, and vehicle-based options for decreasing distracted driving and alcohol involvement in crashes. Requested funding will support vehicle safety research into the reliability and security of complex safety-critical electronic control systems; studying the cybersecurity of vehicles; and assessing new and emerging technologies that can help drivers avoid crashes."[17]

The FY 2016 budget requests $39.7 million for NHTSA's Vehicle Safety Research and Analysis programs, which includes the following research areas:[18]

Program Activity	FY 2015 Enacted	FY 2016 Request
Safety Systems	$7.4	$8.2
Biomechanics	$9.9	$11.0
Heavy Vehicles	$1.9	$2.0
Crash Avoidance	$7.4	$10.4
Alternative Fuels Vehicle Safety	$1.4	$3.0
Vehicle Electronics and Emerging Technology	$0	$4.1
Vehicle Research and Test Center	$0.5	$1.0

Budget in Millions of Dollars

The FY 2016 NHTSA budget also requests $152 million for Highway Safety Research and Development, which includes "research activities to reduce highway fatalities, prevent injuries, and significantly reduce the economic toll of motor vehicle crashes by data collection and analysis, research into highway safety issues, and the development of effective countermeasures."[19]

[16] $908 million requested for FY 2016; http://www.dot.gov/sites/dot.gov/files/docs/FY2016-BudgetEstimate-NHTSA.pdf
[17] http://www.dot.gov/sites/dot.gov/files/docs/FY2016-BudgetEstimate-NHTSA.pdf
[18] http://www.transportation.gov/sites/dot.gov/files/docs/FY2016-BudgetEstimate-NHTSA.pdf
[19] http://www.dot.gov/sites/dot.gov/files/docs/FY2016-BudgetEstimate-NHTSA.pdf

Federal Railroad Administration (FRA)[20]

The FRA Railroad Research and Development (R&D) Program focuses on improving railroad safety. The mission of the program is "to ensure the safe, efficient and reliable movement of people and goods by rail through basic and applied research, and development of innovations and solutions."[21]

The FY 2016 budget requests $39.3 million for FRA's Railroad R&D Program, which includes the following research areas:[22]

Program Activity	FY 2015 Enacted	FY 2016 Request
Track Program	$11.3	$11.4
Rolling Stock Program	$10.3	$10.3
Train Control and Communication	$8.1	$8.1
Human Factors Program	$5.5	$5.5
Railroad Systems Issues	$3.9	$3.9

Budget in Millions of Dollars

Federal Motor Carrier Safety Administration (FMCSA)[23]

The FMCSA Research and Technology (R&T) Program "provides scientific safety research on driver behavior, carrier operations, and technology applications....Program activities range from developing enhanced enforcement technology through wireless roadside inspections, demonstrating the efficacy of truck drivers getting proper rest, and understanding how commercial motor vehicles can safely use alternative fuels."[24]

The FY 2016 budget requests $9.7 million for FMCSA's R&T Program, which includes the following research areas:[25]

Program Activity	FY 2015 Enacted	FY 2016 Request
Produce Safe Drivers	$2.5	$4.8
Improve Safety of Commercial Vehicles	$2.7	$2.8
Produce Safer Carriers	$1.2	$2.0
Advanced Safety through Info-Based Initiatives	$2.8	$0.5

Budget in Millions of Dollars

[20] $5.0 billion requested for FY 2016; http://www.dot.gov/sites/dot.gov/files/docs/FY2016-BudgetEstimate-FRA.pdf
[21] http://www.dot.gov/sites/dot.gov/files/docs/FY2016-BudgetEstimate-FRA.pdf
[22] http://www.dot.gov/sites/dot.gov/files/docs/FY2016-BudgetEstimate-FRA.pdf
[23] $668.5 million requested for FY 2016; http://www.dot.gov/sites/dot.gov/files/docs/FY2016-BudgetEstimate-FMCSA.pdf
[24] http://www.dot.gov/sites/dot.gov/files/docs/FY2016-BudgetEstimate-FMCSA.pdf
[25] http://www.dot.gov/sites/dot.gov/files/docs/FY2016-BudgetEstimate-FMCSA.pdf

Reports

The following reports provide background and context for research, development and technology issues relevant to the hearing.

Legislative

The Science Committee mandated the requirement for the DOT to develop strategic RD&T plans in the 2005 Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU, P.L. 109-59), as well as in the 2012 Moving Ahead for Progress in the 21st Century Act (MAP-21, P.L. 112-141).

The 2005 plan established a five-year pathway for DOT research activities and mandated that the Transportation Research Board (TRB) independently review the plan and identify strengths and weaknesses. Similarly, the 2012 legislation required an updated strategic plan and another independent review by TRB of the current FY 2013 to 2018 plan titled, "*Research, Development, and Technology Strategic Plan.*"[26]

Transportation Research Board

Special Report 317: *The Essential Federal Role in Highway Research and Innovation*[27]

Earlier this year TRB issued Special Report 317 via the Research and Technology Coordinating Committee (RTCC). RTCC serves as an independent advisor on national and federal highway research, and Special Report 317 "aims to inform the impending reauthorization of MAP-21by providing background and context for decisions about future federal funding of highway RD&T."[28] According to the report, reductions in resources for FHWA – human and financial – would "hamper the agency's ability to continue to fulfill its essential roles and responsibilities....If substantial reductions do occur, the pace of innovation on the nation's highways will likely slow to a crawl at a time when public expectations for improved safety and greater reliability, as well as reduced revenues for maintenance and upkeep, are placing growing demands on the national highway system."[29]

Special Report 313: *Framing Surface Transportation Research for the Nation's Future*[30]

Last year, TRB issued Special Report 313 in response to requests from state departments of transportation and the National Cooperative Highway Research Program to consider "whether and how the lessons learned from transportation research in other countries, and from research in domestic nontransportation sectors, might be used to improve surface transportation research in the United States."[31] The request came about as a result of concerns related to a constrained budget environment and a desire to maximize the efficiency and effective use of scarce public funds.

The report describes the U.S. surface transportation research enterprise as decentralized, with research programs initiated from the bottom up reflecting the priorities of its diverse participants, activities, and funding sources. Consequently, "much of the research aims at specific problems identified

[26] https://www.rita.dot.gov/rdt/sites/rita.dot.gov.rdt/files/rdt_strategic_plan_2013.pdf
[27] http://onlinepubs.trb.org/onlinepubs/sr/sr317.pdf
[28] http://onlinepubs.trb.org/onlinepubs/sr/sr317.pdf
[29] http://onlinepubs.trb.org/onlinepubs/sr/sr317.pdf
[30] http://www.nap.edu/openbook.php?record_id=18611
[31] http://www.nap.edu/openbook.php?record_id=18611

by sponsors and is relatively short term and applied in nature."[32] While there have been important transportation improvements, there have been missed opportunities too because of the imbalance between bottom-up and top-down approaches. The US system "tends to focus on solving narrowly defined problems at the expense of basic and advanced research that could form the basis for exploring broader crosscutting issues and developing innovative solutions to long-term challenges."[33]

The report suggests establishing a new and more cohesive national framework to strengthen US surface transportation research led by the "Standing Committee on Research of the American Association of State Highway and Transportation Officials and comprised of representatives from the public, private, academic, and nonprofit sectors."[34] The report also recommends federal action in support of the transition to this new framework. Recognizing that while DOT has much of the responsibility for US transportation systems, other agencies, such as the Department of Energy and Department of Defense, also contribute to transportation research within their respective missions. Notably, the report suggests that to "make better use of federal resources, the White House Office of Science and Technology Policy should create a task force to explore potential synergies and gains from greater coordination among pertinent agencies."[35]

[32] http://www.nap.edu/openbook.php?record_id=18611
[33] http://www.nap.edu/openbook.php?record_id=18611
[34] http://www.nap.edu/openbook.php?record_id=18611
[35] http://www.nap.edu/openbook.php?record_id=18611

Figure 1

U.S. Department of Transportation
Office of the Assistant Secretary for Research and Technology

FY 16 President's Budget Request ($000)
Research, Development and Technology (RD&T) Funding by Office/Operating Administration and Funding Source

	TOTAL	Airport and Airway TF	Transportation TF[1]	General Fund (GF)
USDOT Total R&D Budget by Funding Source	**$ 1,444,294**	**$ 420,236**	**$ 957,119**	**$ 66,939**
Federal Aviation Administration	**$ 420,236**	**$ 420,236**		
Research, Engineering and Development		$ 166,000		
Improve Aviation Safety		*$ 96,623*		
Improve Efficiency/Economic Competitiveness		*$ 24,671*		
Reduce Environmental Impact		*$ 38,884*		
Mission Support		*$ 5,822*		
Facilities and Equipment		$ 198,050		
Airport Improvement Program (T)		$ 46,000		
Operations		$ 10,186		
Federal Highway Administration	**$ 701,247**		**$ 701,247**	
Highway Safety Research and Development			$ 130,000	
Technology and Innovative Deployment Program (T)			$ 70,000	
Future Strategic Highway Research Program Implementation (T)			$ 25,000	
Training and Education (T)			$ 27,000	
Intelligent Transportation Systems			$ 158,000	
ITS Multi-Modal Research			*$ 133,540*	
Technology Transfer and Evaluation (T)			*$ 18,460*	
ITS Program Support			*$ 6,000*	
University Transportation Research (T)			$ 82,000	
State Planning and Research (SP&R)			$ 189,839 [2]	
Administrative Expenses			$ 19,408	
Federal Motor Carrier Safety Administration	**$ 13,373**		**$ 13,373**	
Produce Safe Drivers			$ 4,848	
Improve Safety of Commercial Vehicles			$ 2,835	
Produce Safer Carriers (T)			$ 1,955	
Advanced Safety Through Info-Based Initiatives (T)			$ 500	
Enable and Motivate Internal Excellence			$ 550	
Administrative Expenses (R&D)			$ 2,685	
Federal Railroad Administration	**$ 68,278**		**$ 25,000**	**$ 43,278**
Railroad Research and Development				$ 39,250
Track Program				*$ 11,429*
Rolling Stock Program				*$ 10,322*
Train Control and Communication				*$ 8,086*
Human Factors Program				*$ 5,542*
Railroad Systems Issues Program				*$ 3,871*
Rail Service Improvement Program (R&D)			$ 25,000	
Salaries & Expenses (R&D)				$ 4,028
Federal Transit Administration	**$ 62,193**		**$ 62,193**	
National Research Program			$ 26,000 [3]	
Technical Assistance and Standards Development (T)			$ 7,000 [3]	
Human Resources and Training (T)			$ 20,000	
Transit Cooperative Research Program (T)			$ 7,000	
Low to No Emissions Program (T)			$ -	
Administrative Expenses			$ 2,193	

Figure 1 (contd.)

U.S. Department of Transportation
Office of the Assistant Secretary for Research and Technology

FY 16 President's Budget Request ($000)
Research, Development and Technology (RD&T) Funding by Office/Operating Administration and Funding Source

Maritime Administration	$ -		
National Highway Traffic Safety Administration	$ 141,510	$ 141,510	
Research and Analysis		$ 74,784	
Crashworthiness		*$ 19,188*	
Crash Avoidance		*$ 10,088* [4]	
Data Programs (T)		*$ 45,508*	
Alternative Fuels Vehicle Safety		$ 3,000	
Vehicle Electronics and Emerging Technology		$ 2,000	
Vehicle Test Center - Ohio		$ 2,500	
Highway Safety Research		$ 6,142	
Administrative Expenses		$ 53,084	
Pipeline and Hazardous Materials Safety Administration	$ 22,012	$ 13,796	$ 8,216
Pipeline Safety		$ 12,433 [5]	
Hazardous Materials Safety			$ 7,670
Administrative Expenses		$ 1,363	$ 546
Saint Lawrence Seaway Development Corporation	$ -		
Office of the Secretary	$ 15,445		$ 15,445
Transportation Planning, Research and Development			$ 10,019
Assistant Secretary for Research and Technology			$ 5,426
Alternative Fuels R&D			*$ 499*
R&D Planning and Management			*$ 509*
Administrative Expenses			*$ 2,808*
Positioning, Navigation and Timing			*$ 1,610*
Bureau of Transportation Statistics		[$ 29,000] [6]	
University Transportation Centers		[$ 82,000] [6]	
Intelligent Transportation Systems		[$ 158,000] [6]	
DOT SUBTOTALS	$ 1,444,294		
Research and Development	$ 1,000,142		
Technology Investment (T)	$ 398,701		
Facilities (F)	$ 45,451		

Definitions

R&D: This budget activity includes: basic research (without specific application); applied research (for a specific need); and developmental research (design, development and improvements of prototypes and processes.

Technology: Demonstration projects and other related activities associated with research and development activities.
Facilities: Acquisition, design and construction and repairs of all physical facilities for use in research and development activities.

[1] The FY16 President's Budget proposes to rename the "Highway Trust Fund" to the "Transportation Trust Fund" as part of the Administration's GROW AMERICA Act proposal.
[2] Estimated. 23 USC 505(b) requires State DOTs to expend no less than 25% of their annual STP&R funding on RT&E activities.
[3] Through FY15, Transit Research and Training was funded through the General Fund. The President's FY16 Budget Request moved this program to the Transportation TF.
[4] Through FY15, Research and Analysis-Vehicle Safety was funded through the General Fund. The President's FY16 Budget Request moved this program to the Transportation TF.
[5] Pipeline Safety R&D funded through the Pipeline Safety Fund (PSF).
[6] Resources are shown as non-adds because the funding resides in the FHWA Research, Technology and Education budget line.

Chairwoman COMSTOCK. Good morning. The Subcommittee on Research and Technology will come to order. Without objection, the Chair is authorized to declare recesses of the Subcommittee at any time. Welcome to today's hearing, titled Surface Transportation Technology: Driving the Future. In front of you are packets containing the written testimony, biographies, and truth in testimony disclosures for today's witnesses. I now recognize myself for five minutes for an opening statement.

The products that flow through our networks of highways, railroads, and pipelines are the lifeblood of our country's economy, and the nation's transportation infrastructure is the vital network through which it must flow. Consequently, dollars spent on the research and development and technology activities of the Department of Transportation are essential to the nation's prosperity. These efforts support critical infrastructure, and enhance both a healthy economy and the most efficient transportation system that our technology can provide. Today's hearing provides the Committee with an opportunity to examine research and development priorities at the Department, and to understand the important policy issues regarding the future of surface transportation.

We hold this hearing amidst the ongoing efforts to replenish the Highway Trust Fund, and make for long-term investment and planning. I'm intimately familiar with these concerns, because, in addition to my role as Chairwoman of the Subcommittee, I also serve on the House Committee on Transportation and Infrastructure, and I also live in a district filled with a diverse group of transportation challenges, from highway construction to metro and airport issues. Transportation funding challenges are not just a transportation policy issue, but a science and technology issue. We know that the technology industry can provide us with breakthroughs for more efficient uses of our transportation dollars and better results on the ground. A shortfall in research and development funding would have real life consequences on technological advancements involving not just cars, trucks, and trains, but highways, bridges, and pipelines also. Later today we will hear more about one such exciting technology from one of our witnesses on the topic of autonomous cars. But while we may be several years away from the world of driverless cars, another important technology that can save lives already exists today.

By law, positive train control, or PTC, technology is required on 60,000 miles of railroad track by the end of this year. The benefits can't come soon enough, as evidenced by last month's Amtrak derailment outside Philadelphia. Positive train control technology, we heard in the Transportation Committee recently, would've stopped the train from taking that 50 mile an hour turn at a speed of 106 miles per hour, and, obviously, would've changed the devastating results in that case. While Amtrak is on schedule to meet the deadline to implement PTC for its Northeast Corridor by the end of the year, there are other railroads that have told us to date that they can't make that deadline. Closer to home, our nation's metro system suffers from outstanding safety issues that require continuous vigilance by Congress, as well as the full support of the federal government for technological upgrades that would benefit many of us here in the room today.

Today's hearing will also provide the Committee an opportunity to understand research and development activities in surface transportation both at federally sponsored research institutions, as well as the state level entities, such as the one representing the University of Virginia. I look forward to hearing everyone's testimony today, and to engage in a productive and fruitful discussion on U.S. surface transportation, research, development, technology, investments, priorities, and policies. I also look forward to continuing to work with many of you to maximize the effectiveness of the research and development that we—that Congress does as we reauthorize the federal surface transportation programs. Thank you all for joining us today.

[The prepared statement of Chairwoman Comstock follows:]

PREPARED STATEMENT OF SUBCOMMITTEE
CHAIRWOMAN BARBARA COMSTOCK

The products that flow through our networks of highways, railroads and pipelines are the lifeblood of our country's economy, and the nation's transportation infrastructure is the vital network through which it must flow. Consequently, dollars spent on the research, development and technology—or RD&T—activities at the Department of Transportation are essential to the nation's prosperity. These efforts support critical infrastructure, and enhance both a healthy economy and the most efficient transportation system.

Today's hearing provides the Committee with an opportunity to examine RD&T priorities at the Department of Transportation, and to understand the important policy issues regarding the future of surface transportation. We hold this hearing amidst the ongoing efforts to replenish the Highway Trust Fund with long term investment and planning.

I am intimately familiar with these concerns because in addition to my role as Chairwoman of this Subcommittee, I also serve on the House Committee on Transportation and Infrastructure. I also live in a district filled with a diverse group of transportation challenges; from highway congestion to metro and airport issues.

Transportation funding challenges are not just a transportation policy issue, but a science and technology issue. We know the tech industry can provide us with breakthroughs for more efficient uses of transportation dollars and better ways to help relieve congestion.

A shortfall in RD&T funding would have real life consequences on technological advancements involving not just cars, trucks and trains, but highways, bridges and pipelines too. Later today we will hear more about one such exciting technology from one of our witnesses on the topic of autonomous cars. But while we may be several years away from a world of driverless cars, another important technology that can save lives already exists today.

By law, Positive Train Control—or PTC—technology is required on 60,000 miles of railroad track by the end of this year. The benefits can't come too soon as evidenced by last month's Amtrak derailment outside Philadelphia. Positive Train Control technology would have stopped the train from taking a 50 mile-per-hour turn at a speed of 106 miles per hour, and prevented the resulting fatalities and injuries. While Amtrak is on schedule to meet the deadline to implement PTC for its Northeast Corridor by the end of the year, it is troubling to note that many railroads are likely to miss the deadline, perhaps necessitating additional Congressional action.

Closer to home, our nation's Metro system suffers from outstanding safety issues that require continued vigilance by Congress as well as full support of the federal government for technological upgrades that would benefit many of us in the room today who rely on this form of transportation.

Today's hearing will also provide the Committee an opportunity to understand RD&T activities in surface transportation both at federally sponsored research institutions, as well as at state-level entities such as the one representing the University of Virginia.I look forward to hearing everyone's testimony and to engage in a productive and fruitful discussion on U.S. surface transportation research, development, technology, investments, priorities, and policies.

I also look forward to continuing to work with many of you to maximize the effectiveness of surface transportation RD&T programs as Congress attempt to reauthorize the federal surface transportation programs. Thank you all for joining us today.

Chairwoman COMSTOCK. And I now recognize the Ranking Member, the gentleman from Illinois, for his opening statement.

Mr. LIPINSKI. Thank you, Chairwoman Comstock. Thank you for calling this hearing. And one other thing, can you fix the Metro for us? Umm . . .

Chairwoman COMSTOCK. We're all working together on that.

Mr. LIPINSKI. Do everything I can, and riding it every day out here. I appreciate the witnesses for being here, and I look forward to their testimony.

Whether by car, train, bus, or foot, we all have to rely on transportation system for our daily commutes and longer distance travel. When it works, everyone's happy, but when it doesn't, the results can range from annoying to catastrophic. With the U.S. population predicted to increase by nearly 30 percent by 2050, we have to find ways to move people and freight more efficiently and more safely. Our current system of roads, bridges, railroads, and transit lines will not be sufficient to support the additional influx of people. In some instances, it's not sufficient right now. This is something we struggle with on the Transportation Committee, which both the Chairwoman and I serve on.

But the answer will not simply be building more and bigger, because it is not clear that we will have the funding, the popular support, or the land to do that. So what do we do? Well, surface transportation used to be rather staid and unimaginative, some might say boring. But today, through research and innovation, the very concept of mobility is being reinvented. This is the key to meeting the transportation demands of our nation, and we in Congress must do our part to help the researchers, innovators, and entrepreneurs revolutionize transportation. As an engineer, this is something I've been interested in and involved in during my ten plus years on this Committee, and we're—there—the rapid advances that are being made, I'm very interested to hear from our witnesses about today.

The research title of the upcoming surface transportation bill provides an important opportunity for this Committee to provide more guidance to the Department of Transportation on national transportation R&D priorities for highways, public transportation, rail, and freight. As I discussed in my recent op-ed in The Hill, we have to make federal investments in research that will provide a safer and more efficient transportation system for future generations. Long term transformational research must be prioritized in the federal budget, and we have to ensure that our federal research partners, particularly University Transportation Centers, are able to conduct advanced research. I have drafted a bill that will help us to do that, and help the U.S. usher in a new age of transportation innovation. I look forward to hearing the panel's thoughts in this direction.

I recently convened an advanced transportation technology roundtable in Silicon Valley, in which I heard from OEMs, tier one suppliers, and tech startups. While we talked about new ideas for making mobility more efficient, more environmentally friendly, and more available to everyone, a common theme was a need for improved connected infrastructure and information technology capabilities. Cars talking to each other was once a thing of science fic-

tion. At a Connected Car Coalition roundtable I spoke to in March, automakers, the telecom industry, and the DOT all agreed that this technology is now at hand. This includes wireless communications that can help cars see around corners. The 5.9 Gigahertz spectrum that is currently reserved for transportation safety communication can prevent up to 80 percent of crashes, according to NHTSA. It is important that this spectrum can be used to prevent accidents and save lives.

Next on the horizon are autonomous vehicle systems. This week the National Transportation Safety Board recommended that all new vehicles be equipped with active collision avoidance systems, and Google has indicated fully autonomous cars could be only five years away. As we will hear from Delphi, they drove a vehicle across the U.S. that was autonomous for 99 percent of the time. Until that very challenging last one percent of automation is achieved, more work is needed, including human factors research to understand how drivers will re-engage with driving after being engrossed in their phones or a movie for an extended period of time.

These technologies incorporate findings from many areas of basic research and related technologies that have been funded for decades by agencies such as NSF, NIST, NASA, and DOD. It is not difficult to imagine how planetary rover technology for space exploration, and how defense robotic technology is playing a part in advancing driverless car technology. It is imperative that the Department of Transportation continue to actively collaborate with other agencies to help translate this research into advances in autonomous vehicles.

Finally, among the issues I think need to be addressed is freight research. I represent part of Chicago, a city to which 25 percent of all freight travels at some point in its journey across our nation. Freight volume is projected to increase by 25 percent by 2025. Freight movement is a national problem, and we need a federal research program to address these challenges. I hope Mr. Winfree and Dr. Meyer will let us know what Congress can do in the next reauthorization to help the Assistant Secretary advance these and other modal administrations research recommendations. Identifying the research priorities for the nation's transportation system is critical to the safety of our citizens, and our economic competitiveness, and the Committee on Science, Space, and Technology has an important role to play.

Again, I want to thank the Chair for calling this hearing, and I look forward to the witnesses' testimony on this important subject.

[The prepared statement of Mr. Lipinski follows:]

PREPARED STATEMENT OF SUBCOMMITTEE
MINORITY RANKING MEMBER DANIEL LIPINSKI

Good morning and thank you, Chairwoman Comstock, for calling this hearing. I appreciate thewitnesses being here and look forward to their testimony.

Whether by car, train, bus or by foot we all have to rely on the transportation system for our daily commutes and longer distance travel. When it works everyone is happy, but when it doesn't the results can range from annoying to catastrophic. With the U.S. population predicted to increase by nearly 30 percent by 2050, we have to find ways to move people and freight more efficiently and more safely. Our current system of roads, bridges, railroads, and transit lines will not be sufficient

to support the additional influx of people. Moreover, it is not clear that we will have the funding, the popular support, or the land to just build more. Instead, we must make our infrastructure work smarter.

Surface transportation used to be rather staid, unimaginative. Some might say boring. But today the very concept of "mobility" is being reinvented. I believe that research and development are critical to meeting the future transportation demands of our Nation, and we in Congress must do our part to help bring about this revolution.

The research title of the upcoming surface transportation bill provides an important opportunity for this Committee to provide more guidance to the Department of Transportation on national transportation R&D priorities for highways, public transportation, rail, and freight. As I discussed in my recent Op-Ed in The Hill, we have to make federal investments in research that will provide a safer transportation environment for future generations. Long-term, transformational research must be prioritized in the federal budget and we have to ensure that our federal research partners, particularly University Transportation Centers, are able to conduct advanced research.

I am working on a bill that will help the U.S. usher in a new age of transportation innovation. I look forward to hearing the panel's thoughts in this direction.

Among the issues I think need to be addressed is freight research. I represent part of Chicago, a city through which 25% of all freight travels at some point in its journey. Freight volume is projected to increase 25% by 2025. Freight is a national problem, and we need a federal research program to address these challenges.

I recently convened an advanced transportation technology roundtable in Silicon Valley in which I heard from OEMs, Tier 1 suppliers, and tech start-ups. While I heard about new ideas for making mobility more efficient, more environmentally friendly, and more available to everyone, a common theme was the need for improved connected infrastructure and information technology capabilities. Cars talking to each other was once a thing of science fiction. At a Connected Car Coalition Roundtable I attended in March, automakers, telecom industry, and DOT all agreed that this technology is now at hand. This includes wireless communications that can help cars see around corners. The 5.9 Giga Hertz spectrum that is currently reserved for transportation safety communication can prevent up to 80% of crashes according to NHTSA. It is important that this spectrum be used to prevent accidents and save lives.

Next on the horizon are autonomous vehicle systems. This week the National Transportation Safety Board recommended that all new vehicles be equipped with Active Collision Avoidance Systems, and Google has indicated fully autonomous cars could be only five years away. As we will hear from Delphi, they drove a vehicle across the U.S. that was autonomous for 99% of the time. Until that very challenging last 1% of automation is achieved, we need human factors research to understand how drivers will re-engage with driving after being engrossed in their phones or a movie for an extended period of time. These technologies incorporate findings from many areas of basic research and related technologies that have been funded for decades by agencies such as the National Science Foundation, the National Institute of Standards and Technology, NASA, and the Department of Defense. It is not difficult to imagine how planetary rover technology for space exploration and how defense robotic technology is playing a part in advancing driverless car technology. It is imperative that the Department of Transportation continue to actively collaborate with other agencies to help translate this research into advances in autonomous vehicles.

I hope Mr. Winfree and Dr. Meyer will let us know what Congress can do in the next reauthorization to help the Assistant Secretary advance these and other modal administrations' research recommendations. Identifying the research priorities for the nation's transportation system is critical to the safety of our citizens and our economic competitiveness, and the Committee on Science, Space, and Technology has an important role to play. Again, I want to thank the Chair for calling this hearing, and I look forward to the witnesses' testimony on this important topic.

I yield back.

Chairwoman COMSTOCK. I now recognize the Chairman of the full Committee, Mr. Smith.

Chairman SMITH. Thank you, Chairwoman Comstock again for holding this hearing, and appreciate the witnesses who are here, and look forward to their testimony.

The future of America's transportation systems depends on the effective development and use of new technologies. Technology en-

hances the capacity and safety of our roadways, railways, and other transportation systems. Technology can relieve traffic congestion, and enable our pipelines to safely transport hazardous materials. This will boost economic efficiency, reduce cost, and improve productivity.

The federal government's investments in the transportation network should be targeted to achieve desired outcomes. The Department of Transportation's current five year research, development, and technology strategic plan merges Congress's priority from the 2012 transportation bill, commonly referred to as MAP 21, with the Department's strategic plan goals. It creates five research, development, and technology priority areas for Fiscal Years 2013 to 2018. Those include promoting safety, extending the life of future transportation systems, improving the movement of goods, reducing congestion, and improving mobility, and protecting the environment. If we focus on smart priorities, the investments we make today will improve the future of transportation.

Cutting edge concepts encompass a broad range of information and communications technologies that have the potential to improve the safety, efficiency, and performance of our nation's transportation system. The issues before us today touch on all modes of surface transportation, and impact every American. High priority research and development will not only help create autonomous automobiles, and improve crash avoidance, and other safety technologies, it will also lead to better roads. Some examples include the use of nanotechnology to create new and better road surfacing materials, and the development of new means of integrating multimode transportation. This will allow Americans to navigate the roads more easily and comfortably.

It is essential that we find a way to maintain a healthy, substantive research base for our state and local transportation initiatives. We have to ensure that Congress gets its priorities right, and avoid duplication of research, in order to ensure taxpayers receive maximum value for their hard earned tax dollars. This makes the Committee's jurisdiction over the research, development, and technology programs at the Department of Transportation particularly relevant.

Thank you, Madam Chair, again. I look forward to our witnesses.

[The prepared statement of Chairman Smith follows:]

PREPARED STATEMENT OF COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY
CHAIRMAN LAMAR SMITH

Thank you Chairwoman Comstock for holding today's hearing.

The future of America's transportation systems depends on the effective development and use of new technologies. Technology enhances the capacity and safety of our roadways, railways, and other transportation systems. Technology can relieve traffic congestion and enable our pipelines to safely transport hazardous materials. This will boost economic efficiency, reduce costs and improve productivity.

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tation systems; improving the movement of goods; reducing congestion and improving mobility; and protecting the environment.

If we focus on smart priorities, the investments we make today will improve the future of transportation. Cutting edge concepts encompass a broad range of information and communications technologies that have the potential to improve the safety, efficiency and performance of our nation's transportation system.

The issues before us today touch on all modes of surface transportation and impact every American. High priority research and development will not only help create autonomous automobiles and improve crash avoidance and other safety technologies, it will also lead to better roads.

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It is essential that we find a way to maintain a healthy, substantive research base for our state and local transportation initiatives. We have to ensure that Congress gets its priorities right and avoid duplication of research in order to ensure taxpayers receive maximum value for their hard-earned tax dollars.

This makes the Committee's jurisdiction over the research, development and technology programs at the Department of Transportation particularly relevant. I thank our witnesses today for making the effort to be here and for their knowledgeable testimony.

Chairwoman COMSTOCK. Thank you, Mr. Chairman. And I now recognize the Ranking Member of the full Committee for a statement, Mrs. Johnson.

Ms. JOHNSON. Thank you very much, Madam Chair, for holding the hearing, thank our witnesses for being here. This hearing was called to review research and development programs at the Department of Transportation, and to review the relationship between the Department and non-federal entities that also conduct transportation research.

Last year, almost to this day, the Committee held a hearing to examine the impact of research and technology on the future of transportation. These are very general topics, and it is good to have a general overview now and then, however, I hope we will also have the opportunity to move and look more thoroughly—and examine more thoroughly specific transportation R and D topics in this Congress.

As a member of the Science, Space, and Technology Committee, and the Transportation and Infrastructure Committee, for 22–1/2 years now, I am keenly aware that transportation disasters have been filling the news over the last several weeks. My thoughts and prayers are with the victims and families affected by the fatal Amtrak crash in Philadelphia last month, my Dallas district, and surrounding areas of North Texas, overwhelmed last month by days of heavy rain, where 1 night 7 inches of rain fell and shut down roads for days, and of course the rest of the state. Having a district that has five interstates crossing it, Interstate 20, 30, 35, 45 and 635, I'm keenly aware of how much we need research to make sure that when repairs are done, they can stay in place.

With respect to pipelines, the PHMSA inspectors have found that there are 54 to 74 percent corrosion of the pipeline wall, in last month's rupture that spilled 100,000 gallons of crude oil along the California coastline. In light of these recent events affecting our rails, highways, and pipelines, there are a number of technology issues on the minds of our constituents, and this Congress. As we consider reauthorization of surface transportation programs, we must keep that in mind.

We're living in a time that is truly transformational for all modes of transportation. When I think about the potential benefits of connected vehicle technology, I don't think it's too lofty to compare its potential impact to the impact of the Eisenhower interstate highway system 60 years ago on connecting goods and people across the nation. As our population grows, so too is access to public transportation and ride sharing options. From highways, public transportation, to railroads, research and development of innovative technologies and policies can improve the safe and efficient movement of people and freight. My district also has an inland port.

It is equally important to implement policies and support long term advanced research that would lead to revolutionary improvements to our transportation systems. To ensure a tech-savvy transportation workforce, it is also important that we implement policies to incorporate transportation applications in the teaching of STEM fields. My colleagues and I must come together to support a multi-year bipartisan surface transportation reauthorization bill that includes strong R and D provisions with adequate funding levels. I only hope that the Science, Space, and Technology Committee will take the steps necessary to ensure that we have a strong voice in what the bill looks like.

Again, I thank our witnesses for being here today, and I look forward to your testimony. Thank you, and I yield back.

[The prepared statement of Ms. Johnson follows:]

PREPARED STATEMENT OF COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY
RANKING MEMBER EDDIE BERNICE JOHNSON

Good morning, I would like to thank the Chair for holding today's hearing.

This hearing was called to review research and development programs at the Department of Transportation and to review the relationship between the Department and non-federal entities that also conduct transportation research. Last year, almost to the day, this Committee held a hearing to examine the impact of research and technology on the future of transportation. These are very general topics and it is good to have a general overview now and then. However, I hope we will also have the opportunity to more thoroughly examine specific transportation R&D topics this Congress.

Transportation disasters have been filling the news over the last several weeks. My thoughts and prayers are with the victims and families affected by the fatal Amtrak crash in Philadelphia last month. My Dallas district and surrounding areas of North Texas were overwhelmed last month by days of heavy rains where in one night seven inches of rain fell and shut down roads for days. With respect to pipelines, PHMSA inspectors have found that there was a 54 to 74 percent corrosion of the pipeline wall in last month's rupture that spilled 100,000 gallons of crude oil along the California coastline. In light of these recent events affecting our rails, highways, and pipelines, there are a number of technology issues on the minds of our constituents and this Congress as we consider a reauthorization of surface transportation programs.

We are living in a time that is truly transformational for all modes of transportation. When I think about the potential benefits of connected vehicle technology, I don't think it's too lofty to compare its potential impact to the impact of the Eisenhower Interstate Highway System 60 years ago on connecting goods and people across the nation. As our population grows, so too is access to public transportation and ridesharing options.

From highways, to public transportation, to railroads, research and development of innovative technologies and policies can improve the safe and efficient movement of people and freight. It is equally important to implement policies that support long-term, advanced research that will lead to revolutionary improvements to our transportation systems. To ensure a tech savvy transportation workforce, it is also important that we implement policies to incorporate transportation applications in the teaching of STEM fields. My colleagues and I must come together to support

a multi-year, bipartisan surface transportation reauthorization bill that includes strong R&D provisions with adequate funding levels. I only hope that the Science, Space, and Technology Committee will take the steps necessary to ensure that we have a strong voice in what that bill looks like.

Again, I thank the witnesses for being here today and look forward to their testimony.

Chairwoman COMSTOCK. Thank you. At this time I would like to introduce our witnesses. Our first witness is the Honorable Mr. Greg Winfree, Assistant Secretary for Research and Technology for the Department of Transportation. He has also served the Department as the agency's Chief Counsel, Deputy Administrator, Acting Administrator, and as Chairman of the Department of Transportation's Innovation Council. He is also an avid motorcycle rider, and founding member of the USDOT Triskelion Motorcycle Club. Mr. Winfree earned a B.S. degree in Communications and Public Relations from St. John's University, and his law degree from Georgetown University Law Center.

Our second witness is Dr. Michael Meyer. Dr. Meyer is the Chair of the Research and Technology Coordinating Committee for the National Academies Transportation Research Board, and a Senior Advisor for Parsons, Brinkerhoff. Prior to holding these positions, Dr. Meyer was a professor of civil and environmental engineering and Chair of the School of Civil and Environmental Engineering at the Georgia Institute of Technology. Dr. Meyer has earned three degrees in civil engineering, his Bachelor's from the University of Wisconsin, his Master's from Northwestern University, and his Ph.D. from MIT.

Our third witness is Dr. Brian Smith, Director of the Center for Transportation Studies at the University of Virginia. I appreciate getting my son through there, class of 2005. Where he is also—where Dr. Smith, not my son, is also the Chair of the Department of Civil and Environmental Engineering. Dr. Smith was elected fellow of the American Society of Civil Engineers in 2009, and is a recipient of many awards in the fields of transportation and engineering. Dr. Smith received his B.S. in Mechanical Engineering from Virginia Tech—I've got another one who was there—his M.S. in Systems Engineering from the University of Virginia, and his Ph.D. in Civil Engineering from the University of Virginia. And I understand your daughter Cecilia is here today with you, in the audience, so let me also welcome her here, and—it's always nice to have—here visiting, so welcome also.

Our final witness today is Mr. Jeffrey Owens, Chief Technology Officer and Executive Vice President of Delphi Automotive, one of the world's largest automotive parts manufacturers. Mr. Owens has served in a variety of engineering, manufacturing, finance, and product line assignments, including as President of Delphi Asia-Pacific from 2006 to 2009. Mr. Owens earned his Bachelor's Degree in Engineering from Kettering University, and his Master's in Business from Ball State University. He currently serves as the Chairman of the Kettering University Board of Trustees.

In order to allow time for discussion, we ask you to limit your testimony to five minutes, and your entire written statement will be made part of the record. Thank you, and I now recognize Mr. Winfree for five minutes for his testimony.

TESTIMONY OF THE HON. GREGORY D. WINFREE, ASSISTANT SECRETARY FOR RESEARCH AND TECHNOLOGY, UNITED STATES DEPARTMENT OF TRANSPORTATION

Mr. WINFREE. Thank you, Chairwoman Comstock. Ranking Member Lipinski, and Members of the Committee, thank you for the opportunity to appear before you today to discuss the Department of Transportation's surface transportation research, development and technology programs, also known as RD&T. We all recognize that results driven transportation, research and technology are essential for maximizing the federal investment in transportation infrastructure and operations. Our transportation system needs to be smarter, and that's why the Department provided the Grow America Act, a bill that, at its core, shifts the foci of transportation funding discussion from short-term measures to long-term custodianship. We look forward to charting a path toward a common solution together.

Secretary Anthony Foxx highlighted the challenges we face in his strategic framework, entitled Beyond Traffic 2045: Trends and Choices. Beyond Traffic is a draft survey of the major forces shaping transportation and a discussion of the potential solutions that can be adopted to address those forces. It is not prescriptive, it doesn't advocate for specific policies, but it does underscore the critical decisions we're going to have to make, drawing on a variety of data, research, and analysis to frame key questions, such as how can we avoid a future of crumbling infrastructure in gridlock traffic, where our transportation network constrains, rather than enables, our economy? How can we ensure that we are creating the right connections so that all of us can have the best opportunities to access jobs, goods, services, and each other?

When Secretary Foxx unveiled the draft of Beyond Traffic in February, he invited the American public to join him in the discussion, to have a frank conversation about the shape, size, and condition of our transportation system, and how it will meet the needs and goals of our nation for decades to come. And we are pleased that people across the country have answered his invitation. We've received hundreds of comments at events, through webinars, from social media, and on our website, which I also encourage you to visit at transportation.gov/beyondtraffic. Thought leaders, young professionals, and Americans from all walks of life continue to contribute to this effort, and to raise tough questions about the future we all must build.

One of the most important questions is, how will we encourage the development and adoption of new technologies that can make travel safer and more convenient? Innovative technologies can support safer and more efficient vehicles, infrastructure, logistics, and transportation services. New sources of travel data can improve traveler experience, support more efficient management, and inform investment decisions. Automation and robotics will influence all modes of transportation, improving infrastructure maintenance, travel safety, and enable commercial use of autonomous vehicles.

The Department currently invests almost $1.2 billion in transportation research, development and technology activities. To address the challenges we face, the President's fiscal year 2016 budg-

et request increases this investment by almost 30 percent, to over $1.4 billion. The President's request directs research and technology investments to the priority areas highlighted in Beyond Traffic, and other areas important to the transportation enterprise. So I'd like to provide a brief overview of these priorities, but note that my written testimony provides many more details.

The Department has a significant investment in vehicle to vehicle communication technologies, and vehicle automation innovations are developing rapidly, capturing the public's fancy. Grow America seeks to invest $935 million over six years in activities to advance vehicle automation and vehicle to vehicle technologies. The Administration made accelerating deployment of V2V technologies, and swiftly advancing a deployment framework for automated vehicles, a priority, seeking $158 million for the intelligent transportation system research program in fiscal year 2016, a 68 percent increase over inactive levels.

Moreover, in May Secretary Foxx directed the NHTSA to accelerate the timetable for its rulemaking on V2V technology in new vehicles. He also committed to the rapid testing of unlicensed devices, seeking to share the wireless spectrum used by V2V to ensure there was no interference to critical safety of life messages as soon as the production ready devices are provided by industry. And he has asked NHTSA to make sure a regulatory framework promotes the deployment of proven traffic safety innovations in an effort to ensure an accelerated and safe deployment of these applications.

So I'm certainly mindful of time. There was much more in my written testimony, but I would like to conclude by saying that I'm excited about the future of our surface transportation research programs. These programs are vital to achieving the safety, state of good repair, economic competitiveness, quality of life, and environmental sustainability goals of the U.S. Department of Transportation, and the expectations of the American public. We are addressing serious issues and seeking tangible results for the benefit of all citizens and our nation's economy, and I look forward to your questions. Thank you.

[The prepared statement of Mr. Winfree follows:]

WRITTEN STATEMENT OF
GREGORY D. WINFREE
ASSISTANT SECRETARY FOR RESEARCH AND TECHNOLOGY
U.S. DEPARTMENT OF TRANSPORTATION

BEFORE THE

SUBCOMMITTEE ON RESEARCH AND TECHNOLOGY
COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY
U.S. HOUSE OF REPRESENTATIVES

HEARING ON

U.S. Surface Transportation: Technology Driving the Future

June 12, 2015

Chair Comstock, Ranking Member Lipinski, and Members of the Committee, thank you for the opportunity to appear before you today to discuss the breadth and opportunities of the Department of Transportation's research, development and technology (RD&T) programs.

We all recognize that effective and implementable transportation research and technology products are essential tools for maximizing the Federal investment in transportation infrastructure and operations. We need to make our transportation system smarter – more efficient and effective. That's why the Department sent you a new and improved GROW AMERICA Act on March 30. GROW AMERICA is a fully-funded, comprehensive multiyear proposal, which includes 350 pages of smart policy prescriptions and substantial funding growth, including for research and technology, all focused on the future.

The future of the U.S. transportation system in all modes has the potential to be safer, cleaner, more efficient, durable and resilient if the necessary research is performed and results

implemented. All functions, from planning, to construction, to environment, to operations and maintenance, benefit from well-designed and well-funded research and technology programs.

Secretary Anthony Foxx has highlighted the challenges we face, and suggested some of the possible paths forward, in his visionary framework, *Beyond Traffic 2045: Trends and Choices*. If you have not had a chance to review the results of this excellent assessment prepared by staff from across the Department, including leadership from my own organization and our Volpe National Transportation Systems Center, I would encourage you to do so and to provide us your comments. *Beyond Traffic* is informed by the information and opinions provided by the leading thinkers and organizations in American transportation and, more importantly, by regular Americans who engaged with us through multiple webinars and other virtual sessions. We were especially pleased to see the response of young people early in their transportation careers, with whom we made a special effort to connect – after all, we are talking about the future they will be living in.

Beyond Traffic analyzed the condition and performance of our transportation system today, and also forecasted how it will look and perform 30 years from now. *Beyond Traffic* reveals that, if we don't change, in 2045, the transportation system that powered our rise as a Nation will instead slow us down. Transit systems will be so backed up that riders will wonder not just when they will get to work, but if they will get there at all. At the airports, and on the highways, every day will be like Thanksgiving holiday travel is today.

This is not a picture of our inevitable future. Our purpose in producing this report was to analyze the latest data and trends shaping transportation so we could objectively frame critical policy choices that need to be made. Some of the key questions we are asking are: How will we move better? How will we knock down barriers to new technologies that promise to make travel safer and more convenient? For example, we recognize that:

- Technological changes and innovation may transform vehicles, infrastructure, logistics, and the delivery of transportation services to promote efficiency and safety.
- New sources of travel data have the potential to improve travelers' experience, support more efficient management of transportation systems, and enhance investment decisions.
- Automation and robotics will affect all modes of transportation, improving infrastructure maintenance and travel safety, and enabling the mainstream use of autonomous vehicles.

All of these technology and data trends are happening now. I will spend the remainder of my testimony discussing how the Department's RD&T programs are seeking both to enable, and to take advantage of, these fast-moving developments, many of which are coming from outside the traditional transportation industries.

Vehicle-to-Vehicle Technologies and Vehicle Automation

GROW AMERICA invests $935 million over six years in the future of vehicle safety and innovation, including the advancement of vehicle automation and vehicle-to-vehicle technologies. The Administration made accelerating deployment of vehicle-to-vehicle (V2V) technologies, and swiftly advancing the framework to enable automated vehicles, a priority in

the FY 2016 budget request, by seeking $158 million for the Intelligent Transportation Systems (ITS) research program, a 68 percent increase over FY 2015 enacted levels.

On May 13, Secretary Anthony Foxx directed the National Highway Traffic Safety Administration (NHTSA) to accelerate the timetable for its proposal to require V2V technology in new vehicles. He also committed DOT to rapid testing to ensure that the wireless spectrum used by V2V is not obstructed by radio interference. And, he has asked NHTSA to make sure our regulatory framework encourages the deployment of demonstrated traffic safety innovations. Together, these steps will support the current revolution in connected vehicle technologies while also making sure those technologies are safe.

The ITS Program, funded through the Research, Technology, and Education (RT&E) Program and managed by my office through the ITS Joint Program Office, is fully multi-modal. While public attention falls on the vehicle side of our work, we continue to conduct critical research in multi-modal vehicle-to-infrastructure safety and mobility applications. We also continue to advance our work on integrating data streams from multiple sources – roads, transit, freight and vehicles – to increase mobility, efficiency, and capacity while decreasing congestion, travel times and environmental impacts. Phase 1 of the Connected Vehicle Pilots Deployment Program, the solicitation for which closed in mid-March, will further Connected Vehicle implementation, not just for safety, but also to advance both mobility and efficiency applications.

In connected vehicles and automation, we intend to pursue:

- Connected Vehicle Implementation – This program will fill any research gaps identified by NHTSA to support light vehicle safety rulemaking efforts, and will provide research to speed the adoption of safety capabilities for heavy vehicles.
- Vehicle-to-Infrastructure (V2I) – Our research will also develop the capability to use smart infrastructure to support warning drivers of road hazards such as intersection collision, slippery road surfaces, excessive speed on curves, and other conditions that present hazardous or dangerous conditions to drivers. The purpose is to accelerate the next generation of safety applications through widespread adoption of V2I communications to reduce crashes, injuries, and fatalities. This research will also provide valuable information to support the FHWA deployment guidance and accelerate implementation of connected vehicle systems by State and local agencies to increase mobility, freight efficiency, and capacity.
- Automation – This research will enable and accelerate the development and deployment of automated vehicles, ensure safe and efficient operations of emerging technologies and systems, and maximize public benefits by leveraging connected vehicle technologies, infrastructure-based solutions, and other approaches. Building upon the connected vehicle safety research as the logical "bridge" to safe introduction of automated vehicles, the program would undertake three major pilot activities that could demonstrate and evaluate the transformational potential of automated vehicles in a real-world environment while reducing deployment risks for industry and society. These research pilots would facilitate defining performance requirements, as well as objective and threshold performance criteria. This in turn would enable the government, automotive industry, equipment manufacturers, and the standards development organizations to define the

preconditions needed to commercialize and deploy affordable automated vehicle fleets in the U.S. with safety performance superior to today's human-operated vehicles.

- Vehicle-to-Pedestrian – The Department is engaged in a study to identify vehicle-to-pedestrian (V2P) applications that would warn the driver, pedestrian, or both of an impending collision using Dedicated Short Range Communications (DSRC) technology, and is estimating the potential benefits of such warnings. In FY 2014, the Department reviewed and assessed operational and prototype pedestrian detection and warning systems, held two focus group meetings on technology acceptance and usability, and began analyzing the role of DSRC and other communications methods. In FYs 2015 and 2016, the Department plans to test V2P technologies at the Turner-Fairbank Highway Research Center's intersection test bed for market readiness and real world implementation. Both intersection and non-intersection (i.e., mid-block) crashes will be tested. The Department is further considering a project to develop, test, evaluate, and modify a Connected Vehicle safety application that alerts pedestrians of bus movements around bus stops, using V2I and potentially V2P communications.

Dedicated Short Range Communications

At this point, I would like to address a topic I am told is of interest to the Committee, that of the suggested sharing of the Dedicated Short Range Communications (DSRC) spectrum band upon which V2V and V2I communications rely, with unlicensed WiFi devices. All of this V2V and V2I success, and the standards that support it, and the move along the continuum to automation, are based upon the unimpeded availability of the 5.9 gigahertz (GHz) DSRC spectrum. Allocated in the U.S. and internationally for transportation safety, the 5.9 GHz band

was specifically selected to enable the ten-times-per-second exchange of information needed to bring to reality the safety improvements that remain the primary goal of ITS research. We recognize that spectrum is a scarce national resource and that it is important to find ways to expand wireless broadband capacity. DOT continues to believe that saving lives is the most valuable use of this spectrum.

As you know, the FCC in February 2013 published a Notice of Proposed Rulemaking (NPRM) proposing unlicensed (U-NII) device operations in the 5850-5925 MHz band.[1] DOT has been engaged with the FCC and the NTIA to address the technical questions raised by this proposal, and to support the 5850-5925 MHz band feasibility study required by Section 6406 of the Middle Class Tax Relief and Job Creation Act of 2012. DOT has established testing capabilities so that we can analyze interference and sharing possibilities. We are also working with FCC and NTIA to clearly identify the test requirements, facilities and timeline to support testing of interference mitigation techniques that may be employed by 5.9 GHz U-NII devices if they become available from industry.

I want to emphasize that DSRC availability, and the safety benefits proven through the Ann Arbor Safety Pilot Demonstration, undergird and made possible the NHTSA Advance Notice of Proposed Rulemaking (ANPRM). This demonstration testing, and the ANPRM, are the results of almost 20 years of careful and coordinated research and technology development by the auto industry and its suppliers, and DOT, focused on safety and mobility. Public safety

[1] The FCC references the DSRC spectrum band (5.85-5.925 GHz) as Unlicensed National Information Infrastructure (U-NII)-4.

technologies must be well-proven, reliable and mature to be effective. The NHTSA ANPRM concluded that DSRC-reliant safety-critical applications are proven effective, and that the life-saving benefits of DSRC devices far outweigh the costs of mandating those devices in light vehicles. DSRC also supports NHTSA's ongoing work toward a decision on a heavy vehicle rulemaking.

We are ready to work with any interested party to review and analyze U-NII sharing proposals for the 5.9 GHz band. To date, only conceptual sharing proposals have been discussed, and no 5.9 GHz U-NII devices have been offered for testing and analysis. To protect DSRC's life-saving potential, real-world device testing will be required to ensure that potential U-NII devices do not cause harmful interference to critical ITS safety applications in the 5.9 GHz band, as required by the FCC's rules. To this end, DOT has maintained the Ann Arbor test bed beyond its original planned lifetime, and put in place additional spectrum testing agreements and other facilities, to be as ready as possible for live interference testing.

We will also deliver the "Vehicle-to-Vehicle and Vehicle-to-Infrastructure Communications Systems Deployment" report, focused on DSRC, as required by Section 53006 of the Moving Ahead for Progress in the 21st Century Act (MAP-21). Secretary Foxx has challenged us to accelerate delivery of the report to you, and we are working to meet his challenge. On April 28, we received the recommendations resulting from the required National Research Council review of the draft report. The review committee agreed with DOT's draft report about the benefits that DSRC technology offers compared with other communications technologies for safety-critical messages, and also agreed that proposed spectrum sharing in the

5.9 GHz band is the most serious risk and uncertainty of relying on DSRC for safety-critical messages. The committee, however, also identified other unknowns and uncertainties that the report should address, which we are doing before submitting the report to Congress.

Vehicle Safety Research

Continuing with vehicle safety research, the FY 2016 Budget provides NHTSA with $114 million to support safety goals through behavioral research and demonstration programs that focus on issues like distraction and combatting impaired driving, as well as on collecting and analyzing crash data. A total of $7.1 million is requested specifically to conduct research on advanced and emerging technologies and alternative fuel vehicles that require thorough testing to ensure that their level of safety for vehicle occupants is comparable to that of other vehicles.

NHTSA research supports numerous planned or active rulemakings, for example:

- NHTSA consideration of heavy vehicle rear underride guards.
- Agency regulatory actions on child restraint performance standards in side and frontal impacts.
- Possible regulatory actions on frontal oblique crashes, including repeatability and reproducibility testing and analysis.
- Initiating research to evaluate inclusion of an advanced small female dummy into adaptive rear seat, side impact, and frontal oblique testing.
- Supporting potential implementation of a new brain-injury criterion.

NHTSA funding also supports the continued crashworthiness and defect investigations research work of the Vehicle Research and Test Center (East Liberty, OH).

The Federal Motor Carrier Safety Administration (FMCSA) is requesting $10 million for multiyear Research and Technology programs focused on producing safer drivers and carriers. The Research and Technology program provides scientific safety research on driver behavior, carrier operations, and technology applications. These contributions have proven critical in supporting agency safety rulemakings, identifying enforcement priorities, and facilitating technology transfer to the marketplace. FMCSA research will continue to develop enhanced enforcement technologies, measure driver safety, evaluate the safety implications of automated and semi-automated vehicles, and examine how commercial motor vehicles can safely use alternative fuels. These projects provide the underpinnings for the Agency's rulemaking and enforcement priorities. For example, recent research findings demonstrated the safety benefits of carriers' use of electronic logging devices to keep track of driver work hours.

Highways

The President's Budget requests $496 million for the Federal Highway Administration's (FHWA) Research, Technology, and Education (RT&E) Program to provide for a comprehensive, nationally coordinated highway research, technology, and education program, of which $158 million supports ITS Research as discussed earlier. GROW AMERICA carries forward the MAP-21 restructured FHWA research, development, and technology activities, which include a highway research and development program, a technology and innovation deployment program, and a training and education activities program. Research supporting innovative finance efforts is also included. I'd like to highlight some of FHWA's exciting work:

- The Every Day Counts (EDC) initiative seeks to increase innovation at every stage of the highway project lifecycle, and I think is a model of how Federal agencies might better

partner to move research results into practice. Launched in 2010 as a partnership with State and local agencies, EDC has now moved into a third phase focusing on "efficiency through collaboration and technology." These innovations are helping States and localities demonstrate and deploy research results in daily practice, supporting the goals of shortening project delivery times, enhancing roadway safety, reducing congestion, and improving environmental sustainability.

- The Second Strategic Highway Research Program (SHRP 2) was authorized by Congress in 2005 to investigate the underlying causes of highway crashes and congestion in a short-term program of focused research. Managed by the Transportation Research Board of the National Academies, in partnership with the Department and the American Association of State Highway and Transportation Officials (AASHTO), and including many other partners, SHRP 2 targeted goals in four interrelated focus areas: safety, renewal, reliability and capacity. While the research phase has wrapped up, implementation – which began for completed products in 2012 – is moving forward swiftly. FHWA and AASHTO are now promoting their sixth round of SHRP 2 products through the Implementation Assistance Program, with next year's seventh round products already announced. GROW AMERICA provides up to $25 million for SHRP 2 implementation to accelerate innovation delivery and technology implementation.
- FHWA's Turner-Fairbank Highway Research Center sits just up the George Washington Parkway in McLean, Virginia, and I know of few better ways to understand what we do in RD&T than visiting Turner-Fairbank. I invite you to follow President Obama's example – he went to Turner-Fairbank in July 2014 to celebrate our advances in connected vehicles and infrastructure – and visit the laboratories to learn about work in

ITS, advanced operations, human factors, structures, and other research to make highways safer, more efficient, and more environmentally sustainable.

Multimodal Freight Research

Everyone agrees that unsafe freight movements, and freight congestion on all modes, are costly – in lives, increased economic burden, hampered trade, and increased idling emissions and other environmental impacts. All of our operating administrations have programs that address in some way their specific portion of the freight challenge, but few are research and technology-oriented. The Department is prioritizing freight projects through Transportation Investment Generating Economic Recovery (TIGER) grants and other formula programs, by various cross-modal activities and data sharing, and by pursuing the MAP-21 requirements to develop a National Freight Policy, National Freight Network, and National Freight Strategic Plan.

However, what is needed is a multi-modal, collaborative freight research program that brings all parties to the table – shippers, carriers, forwarders, and all levels of government – to address our common issues, issues that are growing as we project that freight volume will increase 45 percent by 2045. GROW AMERICA establishes the National Cooperative Freight Transportation Research Program to provide the research and analytical support to meeting national freight goals. The Program includes a specific, targeted focus on improving the safety of hazardous materials transportation and handling.

GROW AMERICA will improve data and technology support to national freight goals by strengthening the Bureau of Transportation Statistics' (BTS) ability to require responses to

freight and intermodal data surveys, and by enabling nationally-consistent statistics on maritime port performance. The lack of robust, multi-modal freight data is a hurdle to assessing the condition and performance of the national freight system as required by MAP-21; GROW AMERICA efforts to improve data collection are key to rectifying this problem. In addition, the Act will add an ITS freight research, demonstration and applications focus to the ITS Research Program goals. I should note that BTS, a designated independent Federal statistical agency, is also a part of my office. BTS manages and shares statistical knowledge and information on the Nation's transportation systems, including statistics on freight movement, geospatial transportation information, and transportation economics. BTS' flagship product is the Commodity Flow Survey, which is the primary source of national and State-level data on domestic freight shipments by American establishments in mining, manufacturing, wholesale, auxiliaries, and selected retail and services trade industries. *Beyond Traffic* and other DOT publications draw key statistics on freight movement, as well as on passenger travel and the economic consequences of transportation, from BTS.

Hazardous Materials and Pipeline Safety

The safe transportation of hazardous materials is a responsibility shared by all modes of transportation. To continue to build upon its string safety record, the Pipeline and Hazardous Materials Safety Administration (PHMSA) is requesting $22 million in R&D funding for FY 2016.

The Hazardous Materials Safety R&D program is conducting research with the outcome goal of minimizing the risks associated with multimodal transportation. It analyzes these risks to

better understand the contributing factors and to minimize potential impacts, and uses those results to focus research efforts on areas that inform and guide potential future changes in regulations, industry safety practices, alternative opportunities for training development, and global intermodal transport efficiency demands for hazardous materials. PHMSA intends to continue to implement strategies outlined in its *2012-2017 R&D Strategic Plan* and is conducting projects that focus on the safe transport of energy products, particularly crude oil by rail (in close coordination with Federal Railroad Administration (FRA)) and liquefied natural gas (LNG). Increasing domestic production of LNG has resulted in more LNG being transported within the U.S. In addition to nitrogen (inert gas), LNG is primarily comprised of methane along with small amounts of ethane, propane, butane, and some trace amounts of heavier alkanes– all highly flammable gases.

Rail Safety

A critical element of freight and passenger movement is America's rail system, which has been much in the media of late. To continue decades-long progress in rail safety performance, FRA is requesting $3.4 billion in additional resources in FY 2016 to focus on the three most pressing rail safety issues we believe are facing us today:

- Increasing rail transportation of crude oil and its derivatives, such as liquefied petroleum gas, significant levels of rail transportation of ethanol, and preparation for rail shipments of LNG.

- Passenger rail safety issues that have surfaced so far in the wake of Metro-North Commuter Railroad and Amtrak accidents.[2]
- Highway-rail grade crossing, pedestrian safety, and trespass prevention.

While this portion of the Budget Request is not specifically R&D, all aspects of it draw upon past successes in rail research and technology to implement safety strategies and to guide these investments. For example, work performed by FRA and our Volpe Center on the improved crashworthiness of passenger cars found its way into the new car designs deployed by Metrolink in California. When February's Metrolink crash occurred in Oxnard, while it was a tragedy that the engineer died, the new cars clearly reduced deaths and injuries among the passengers.

The President's Budget requests $39.2 million for further rail safety-related research and development activities, including continued support for the Short Line Safety Institute and research on the safe transportation of LNG. FRA will continue its long-term research programs to reduce accident numbers and rates and mitigate the consequences of accidents by investigating railroad safety issues related to human factors, track, rolling stock, hazardous materials, highway-rail grade crossings, trespass, train control and communications systems and other systems. There is $25 million in R&D funding requested to support the proposed Rail Service Improvement Program in GROW AMERICA by making investments at the Transportation Technology Center (TTC) in Pueblo, Colorado.

[2] For example, the National Transportation Safety Board's investigation of the May 12, 2015, Amtrak derailment in Philadelphia is ongoing.

I would also note that GROW AMERICA provides $3.05 billion to assist with the implementation of Positive Train Control (PTC) technology.[3] Previous PTC research focused on shared freight/passenger commuter PTC technical issues and commuter rail PTC compliance to prevent train accidents and incidents on those transit systems. FRA research continues to assist in the nationwide deployment of PTC systems. This activity is a cooperative effort between FRA, Class I railroads, the Association of American Railroads, and other interested parties. This cooperative effort includes technology exchanges and field-testing on the railroads. One of the key elements is the use of FRA's PTC test bed at the TTC to ensure the proper functioning and reliability of the new technology.

Transit Research and Training

In addition to working with FRA on commuter rail safety, the 2016 President's Budget requests $60 million, an 82 percent increase over FY 2015 enacted, for the Federal Transit Administration (FTA) to support research activities that improve the safety, reliability, efficiency, and sustainability of public transportation systems by investing in the development, testing, and deployment of innovative technologies, materials, and processes. These activities will help to create "Ladders of Opportunity" for transit-dependent populations that will help improve access to jobs and educational opportunities. The funding request also includes:

- Transit Cooperative Research Program – provides funding to the National Academy of Sciences to conduct investigative research on subjects related to public transportation.

[3] A PTC system is designed to prevent train-to-train collisions, over-speed derailments, worker injuries from train incursion in the work zones, and train accidents and incidents from movement through track switches in the wrong position.

- Technical Assistance – enables FTA to provide technical assistance to the public transportation industry, with an emphasis on improving access for all individuals and transportation equity.
- Human Resources and Training – enables FTA to carry out human resource and training activities within the transit industry, as well as to establish a competitive workforce development grant program. FTA's goal is to improve the skill sets, knowledge, and abilities of transit industry employees that operate increasingly complex vehicle and equipment systems, and to build new pathways into the transit industry for job seekers.

University Transportation Centers

GROW AMERICA enhances the effectiveness of the current University Transportation Centers (UTCs) program by enabling funds to flow into cross-disciplinary university transportation research, by expanding the sources for grant matching funds to include funding from more Federal-Aid accounts and funding provided by other DOT operating administrations. GROW AMERICA also suggests technical corrections to eliminate guidance that caused confusion for some of the universities seeking to submit proposals.

Since the late 1980s, Congress has acknowledged the important contributions made to transportation research, technology transfer, education and workforce development by America's universities. The UTC Program, managed for the Department by the Office of Research, Development and Technology in my office, is recognized as the flagship university research, education, and technology transfer program. Designed to address cross-modal and multi-modal issues, the UTC Program is one of the few opportunities for DOT to support advanced research,

by enabling universities to use their cross-disciplinary capabilities to conduct the advanced work for which they are well suited.

Covering over 120 universities that bring expertise in multiple disciplines, both traditional (civil engineering) and not (public health, psychology and sociology, studying safety culture), UTCs enable the systemic, interdisciplinary, cross-modal research we need to address increasingly complex challenges that cross traditional boundaries. I am personally pleased that the Department's emphasis on reaching out to Minority Serving Institutions (MSIs) and other underserved groups is adding to our expertise pool. Of the 35 UTC grantees selected in the MAP-21 competition, ten are MSIs, and another 31 MSIs receive funding as team members of a UTC consortium.

UTCs do this while educating undergraduate and graduate students in the technical and problem-solving skills we need moving forward – a "win–win" if I've ever heard one. In 2014, the MAP-21 UTC consortia supported 1,369 undergraduate and graduate students in their transportation-related studies, and awarded 269 degrees – 63 of them doctorates. I always enjoy the opportunity to meet with the bright young students at our UTCs, to hear about what exciting new things they are developing in the laboratories and classrooms, and how their own lives are changing even as they add to our transportation knowledge. I encourage the members of this Committee to take those opportunities as well.

Multimodal Research and Research Coordination

My office was created to manage multimodal research programs and initiatives, and to improve coordination of transportation research within the Department and with external researchers. As noted earlier:

- the Intelligent Transportation Systems (ITS) research program is a multi-modal hub of research activity and has applications across the surface and maritime operating administrations within the Department;
- the University Transportation Centers (UTC) program supports cross-cutting research and workforce development across the entire transportation enterprise; and
- the Bureau of Transportation Statistics (BTS) provides trusted data and statistics on multi-modal freight movements and passenger travel, on the economics of transportation, and on transportation system performance.

In addition, my office is home to three other important cross-modal program offices:

- Volpe, the National Transportation Systems Center (Cambridge, MA) – for over 40 years, Volpe's Federal staff has helped the transportation community navigate its most challenging problems. Volpe's mission is to improve transportation by anticipating and addressing emerging issues and advancing technical, operational, and institutional innovations across all modes. Volpe is 100 percent funded by sponsor projects and receives no appropriated funds. In addition to supporting all DOT operating administrations and the Office of the Secretary of Transportation, Volpe provides multimodal and multidisciplinary expertise to deliver transportation-related innovation to

sponsors from other Federal agencies, State and local governments, and international partners.

- The Transportation Safety Institute (Oklahoma City, OK) – TSI supports the Department's goal to reduce transportation-related deaths and injuries through quality instruction to those entrusted with enforcement and ensuring compliance. For 40 years, TSI has provided training to Federal, State, and local governmental, private sector, and foreign transportation professionals on a cost-recovery basis. More than 800,000 students have received TSI's high-quality safety and security training in aviation, highway traffic, transit, motor carriers, and hazardous materials.
- Positioning, Navigation and Timing (PNT) & Spectrum Management – manages the critical technical task of enabling DOT to fulfill its mandate as the lead civil agency for PNT under the President's National Space Policy (2010). Plans and goals for FY 2016 include:
  - Conducting testing and analysis to ensure protection of the Global Positioning System (GPS) from systems that may cause interference. DOT is implementing the GPS Adjacent Band Compatibility Assessment Plan to research the maximum aggregate power level that can operate in the radiofrequency bands adjacent to GPS without causing harmful interference. The requested funding addresses growing interference to GPS from other sources, with a goal of protecting existing and evolving uses of space-based PNT.
  - Supporting ongoing evaluation of spectrum sharing technologies to determine whether use of Dedicated Short Range Communications (DSRC) for safety-critical

connected vehicle (V2V and V2I) technology applications can co-exist with operation of wireless services.

- Increasing oversight of civil funding and participation in GPS acquisition, development, operations, and modernization.

Improving transportation research coordination is a primary function across my organization. I have already mentioned several cross-modal research projects; our staff have set in place processes to standardize research coordination and technology transfer processes. Chief among these was the creation of the DOT Research Hub, a publicly-accessible database of research projects funded by DOT. My office often leads in coordinating transportation research capabilities with Administration initiatives, and in working with other Federal agencies where there is mutual benefit. Our Volpe Center's multi-modal expertise, and projects that cross modal boundaries, certainly aid in this coordination. I'd like to share with you three recent research coordination success stories, one inside DOT and two outside.

Competitive Academic Agreement Program: PHMSA wanted to reach out to the academic community for outside-the-box pipeline transportation solutions and innovations to address critical pipeline safety needs. PHMSA worked with our UTC grants program staff to develop the competitive grants guidance, based in part on the highly-successful UTC Program competitions. The Competitive Academic Agreement Program (CAAP) began in 2014, already has 79 students involved with the research, and is building an internship program. Their projects are diverse in scope, but all aim to address safety challenges like pipeline damage prevention, leak detection, and pre-regulation pipe. PHMSA is now building CAAP partnerships with

nationally recognized pipeline-related organizations to formally host student presentation sessions. In the long run, PHMSA plans to adopt the most-promising findings into the core research program for further investigation and collaboration with their pipeline safety partners.

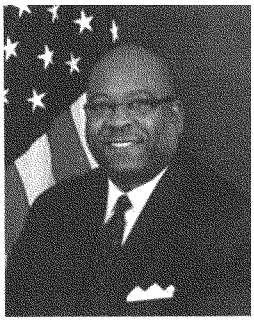
Clean Transportation Sectors Initiative: We are collaborating with the Department of Energy's National Renewable Energy Laboratory to support the Clean Transportation Sector Initiative. The collaboration is looking at best practices that can be used by research practitioners and policy makers in the mapping of optimal directions for the future of the transportation sector and the leveraging of its intersections with other economic sectors such as power and agriculture. This will help lay the foundation to characterize different future transportation sector scenarios that demonstrate the interaction and evolution of the following elements: various networks of fuel, vehicle, and infrastructure technology; critical material requirements; potential disruptive technology impacts; and the applicability to different modes of transportation. This characterization will facilitate the ability to compare and demonstrate the potential integration of pathways towards optimal system deployments that will span the next half-century.

Cyber Physical Systems: My office holds a position on the National Information Technology Research and Development Cyber Physical Systems Senior Steering Group. As a result of coordination through that interdepartmental initiative, the ITS Joint Program Office collaborated with the National Science Foundation on a call for proposals on Cyber Physical Systems. This work follows on the successful project-level collaborations that the FHWA Exploratory Advanced Research Program has been managing for several years.

The Department needs to be more involved in cross-agency research on priority national topics, both to bring transportation expertise to national issues that transportation touches, and to learn more directly from other agencies whose work bears on ours. GROW AMERICA creates a Priority Multimodal Research Program enabling cross-agency research and innovation along three priority areas: infrastructure systems resilience and recovery; advanced research towards a Zero Emissions Transportation System; and a multimodal STEM (Science, Technology, Engineering, and Mathematics) Education and Workforce Development program.

Conclusion

In conclusion, I am excited about the positive impacts that our effective RD&T programs are bringing to the safety, state of good repair, economic competitiveness, quality of life in communities, and environmental sustainability goals of the Department. We are addressing serious issues in serious ways for the benefit of the American public and the American economy. I look forward to answering your questions.



Gregory D. Winfree
Assistant Secretary for Research and Technology
U.S. Department of Transportation

January 24, 2014 – Present

Greg Winfree originally came to the U.S. Department of Transportation's Research and Innovative Technology Administration (RITA) in March, 2010 and was sworn in as its fourth Administrator on October 23, 2013. As directed in the Omnibus Bill of 2014, RITA was elevated to the newly-created Office of the Assistant Secretary for Research and Technology, and on January 23, 2014, Mr. Winfree was sworn in as the Assistant Secretary. During his tenure, Mr. Winfree has also served as the agency's Chief Counsel, Deputy Administrator, and Acting Administrator, and as chairman of the Department of Transportation's Innovation Council.

Prior to his appointments, Mr. Winfree served as Chief Litigation Counsel for Freeport-McMoRan Corporation, a leading international mining and natural resource producer; as Senior Litigation Counsel at Union Carbide Corporation; and as Director of Litigation for Wyeth Pharmaceuticals. Prior to his in-house corporate legal work, Winfree was a Trial Attorney in the Housing and Civil Enforcement Section of the U.S. Department of Justice, Civil Rights Division. He started his legal career as an Associate at the Venable law firm in Washington, D.C.

As both an innovator with design and utility patents to his credit and an experienced Intellectual Property litigator, Mr. Winfree has a special affinity for the Department's diverse transportation research, innovation and knowledge management mission. Much of his career aligns with organizations with a strong focus in the STEM (Science, Education, Technology and Mathematics) disciplines, and in his official capacity at the Department, Mr. Winfree has spoken extensively on the importance of STEM education to the future transportation workforce.

Assistant Secretary Winfree earned a B.S. degree in Communications/Public Relations from St. John's University and a J.D. from Georgetown University, where he served as Lead Articles Editor for *The Tax Lawyer*, the official publication of the American Bar Association Section of Taxation. He carries a valid motorcycle endorsement and is an advocate for advancing safety for motorcyclists and other vulnerable road users. An avid rider, he is a founding member of the USDOT Triskelions Motorcycle Club and has ridden across the country on a number of occasions.

Chairwoman COMSTOCK. Thank you. And I now recognize Dr. Meyer for five minutes to present his testimony.

TESTIMONY OF DR. MICHAEL MEYER, CHAIR, RESEARCH AND TECHNOLOGY COORDINATING COMMITTEE (FHWA), NATIONAL ACADEMIES' TRANSPORTATION RESEARCH BOARD

Dr. MEYER. Thank you, Madam Chair, and Members of the Committee. As mentioned in my introduction, I am Chairman of the Transportation Research Board's Research and Technology Coordinating Committee, which provides guidance on highway research technology programs and advanced research priorities to the Federal Highway Administration. In my past career I've also been a Director in the State Department of Transportation, and responsible for a state transportation program, as well as for 15 years a Director at one of the nation's largest university transportation research centers, so I bring a broad perspective, in terms of some of the issues that you have before you. I'm going to summarize two Transportation Research Board reports that have focused on national transportation research, and then, with the time that's available, I'll provide my own thoughts at the end.

Special Report 313, called Framing Surface Transportation Research for the Nation's Future, was a report that focused on research efforts in other countries around the world, as well as non-transportation domestic organizations, such as the Department of Agriculture, as well as NASA. Based on the analysis, the committee for that report made the following key recommendations. One, they thought there should be a new framework for U.S. surface transportation research that's guided by key national stakeholders in transportation. To a large extent, DOT's strategic plan has started that direction. The recommendation was for the Secretary of Transportation to consider ways to strengthen the coordination of transportation research within the DOT, and, in fact, appoint what they called a Chief Scientist position within the DOT. Third recommendation, focus on making sure that there would be both basic and advanced applied research with regard to the program. And then, finally, the USDOT should continue its activities, in terms of promoting knowledge transfer and dissemination.

Special Report 313, called The Essential Federal Role in Highway Research and Innovation, focused on the Federal Highway Administration, and its role in the national transportation program. The report observed, in fact, that its—the Federal Highway's exploratory advanced research program is the type of basic research that the committee itself was looking for. It focuses on such things as connected highway and vehicle system concepts, breakthrough concepts in material sciences, human behavior and travel choices, technology for assessing performance of the system, as well as organizations, and new technology and advanced policies for energy and resource conservation. This is a type of research that we strongly recommended to Federal Highway as an RTCC, and, in fact, they took that recommendation and implemented that program.

The report concludes that, in fact, that the Federal Highway Administration is in a very unique position to take a long view in re-

search in terms of our nation's highway system, and to do advanced research that will, in fact, contribute to a vehicle to vehicle and vehicle to infrastructure program. With its national perspective, it can lead states in terms of developing and transferring tools and processes that can improve safety and system performance. And, with these economies of scale, in terms of having division offices in every state, it's uniquely positioned to support the implementation of innovations by states and local agencies, in particular developments relating to vehicle to infrastructure programs and standardization of projects and programs that come out of the Strategic Highway Research Program.

So that summarizes, in very general terms, those two reports. Now, just my own observations, I think—I certainly congratulate the Subcommittee on the theme for this hearing, in terms of technology driving the future. My own experience in the field, and in a variety of positions, has really shown that, in fact, technology is one of the driving forces of where we are today, and will likely be in the future. So my own observations with regard to a national surface transportation research program follows. First, I do think the USDOT does have a critical role to play in establishing a research framework that guides not only its own modal agency's research programs, but also those that are under its area of responsibility, such the University Transportation's Research Program.

I think this framework needs to recognize that it's not just government agencies that are doing research. It's the private sector, it's the universities, it's others, and that needs to be provided under kind of a guiding framework in terms of what should happen. The interaction of vehicle and infrastructure in particular I think suggests a very strong role for the USDOT in things like human factors research, as well as system performance and smart infrastructure.

Third, this research portfolio should really combine both basic and applied research. One of the things that I've noticed in the field after many years is that basic research seems to be, well, that goes for National Science Foundation, and applied goes to Transportation, and I think that's a mistake. I think that the applied research community has a lot to offer in terms of understanding some of the basic concepts, the theories that underlie our research programs.

Next, I believe that this base research program should be based on peer review. This is something that we discuss a lot. Both NSF, as well as the Transportation Research Board, has long experience in peer reviewed types of reports. I think that is the best way that we need to go forward as a nation.

So, Madam Chair, and members of the Committee, I really thank you for the opportunity to present my ideas. As the Committee has noted, technology is driving our transportation future, but I would suggest that, in fact, research and development are driving technology, and that it is thus in the national interest to support, foster, and encourage the creativity that lays at the foundation of our technology future, with zero seconds left. Thank you.

[The prepared statement of Dr. Meyer follows:]

U.S. Surface Transportation and Technology Development: The Critical Role for the Research Community

Statement of

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and

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Transportation Research Board
National Research Council
The National Academies

before the

Subcommittee on Research and Technology
Committee on Science, Space and Technology
U.S. House of Representatives

June 12, 2015

INTRODUCTION

Good morning, Madam Chairwoman and members of the Committee. My name is Michael D. Meyer. I am a Senior Advisor to Parsons Brinckerhoff, Inc., one of the nation's leading transportation consulting firms, and currently serve as chairman of the Transportation Research Board's Research and Technology Coordinating Committee (RTCC). The Transportation Research Board (TRB) of the National Academies is one of the five divisions of the National Research Council (NRC), which, in turn, is the operating arm of the National Academy of Sciences, National Academy of Engineering, and the Institute of Medicine. This complex of organizations is collectively referred to as the National Academies. The institution operates under the charter given to the National Academy of Sciences by Congress in 1863 to advise the government on matters of science and technology.

The TRB's mission is to promote innovation and progress in transportation through research. It is best known for its role in promoting innovation and information exchange by maintaining approximately 200 standing technical committees in all modes of transportation and hosting an Annual Meeting that attracts more than 12,000 participants from the United States and around the world. TRB also conducts policy studies for Congress and the executive branch, and administers research programs for others that are stakeholder-directed and primarily award research funding based on competition and merit review by peers.

TRB's Research and Technology Coordinating Committee provides guidance on highway research and technology programs and activities and makes broad-based research priority recommendations, with an emphasis on the Federal Highway Administration's (FHWA's) annual research program plans and budgets. The committee's scope also includes technology transfer and the implementation of research; ways and means of increasing state, local, and private-sector participation in highway research and innovation; and economic, social, energy, and environmental issues as they influence highway research policy and programs.

I should also note that as a state Department of Transportation (DOT) official in the 1980s, I was responsible for a state DOT's research program, and for 15 years I was Director of one of the largest university transportation centers in the country. My background thus provides a broad perspective on the role of research in our Nation's research efforts and their link to future technology development.

The testimony I will give today is focused on two reports prepared by the work of experts, appointed by the NRC, and serving without compensation to examine the role of the federal government in transportation research. I will also offer my own observations, based on years of a range of experience, on aspects of the nation's research program that are important as we move ahead.

Special Report 313, Framing Surface Transportation Research for the Nation's Future [TRB, 2014]

This report examined transportation research efforts in other countries and from domestic non-transportation organizations, and how lessons learned from such efforts might be used to improve surface transportation research in the U.S. The report observes that other nations not only place greater emphasis on transportation research as a means of achieving economic, societal, and environmental goals; they also have effective frameworks for prioritizing, funding, assembling, and coordinating research activities. In contrast, the U.S. surface transportation research enterprise was characterized by a diversity of participants, activities, and funding sources; and it is highly decentralized, with most research programs initiated from the bottom up. As a result, much of the research aims at specific problems identified by sponsors and is relatively short term and applied in nature. The report further noted that, "the U.S. system too frequently lacks clear linkages between research and national goals, and it tends to focus on solving narrowly defined problems at the expense of basic and advanced research that could form the basis for exploring broader crosscutting issues and developing innovative solutions to long-term challenges."

The committee found, not surprisingly, that the research and technology deployment initiatives in other countries differ from the U.S. primarily because of different government structures. However, the assessment found characteristics of research programs that should be common to successful efforts, no matter the governance structure. For example, other countries' research programs were more cohesive in terms of linkage to national transportation and other societal goals; in general, they provided more support for basic research (in Japan, for example, basic research is regarded as an integral part of the overall innovation process and is not artificially separated from other research activities in the funding process); they placed great emphasis on research partnerships among governmental agencies and with private sector firms; and they emphasized the importance of monitoring on-going research to assess research

outcomes in various forms, such as new understanding of basic phenomena, new transportation policies, and new or improved commercial technologies.

With respect to non-transportation research programs, the committee highlighted the fundamental differences between mission-oriented and scientific agencies. By definition, mission-oriented agencies focus on applied research relevant to their mission, with specific targets and an emphasis on implementation. This is certainly a characteristic of much of the research conducted in transportation. The most effective research agenda-setting was inclusive, engaging stakeholders in the establishment of priorities and identification of projects. When rigorous peer review was used to select projects, the research community was more tolerant of the process and the quality of the results appeared to improve. A well-designed stakeholder-engagement process helped identify and overcome barriers to the implementation of research outputs.

Based on their analysis, the committee made the following recommendations:

1. Establish a new framework for U.S. surface transportation research guided by key national stakeholders in transportation.
2. Hold a national summit on transportation research to launch efforts to explore ways of implementing a new national surface transportation research framework, discuss means of funding the framework initiative, and consider opportunities to leverage existing research.
3. The White House Office of Science and Technology Policy (OSTP) should convene a task force to explore potential synergies and other gains from greater coordination and cohesion among federal agencies engaged in research relevant to surface transportation.
4. The Secretary of Transportation should consider ways to strengthen the coordination of transportation research within the U.S. DOT and across other federal agencies, including the creation of a "chief scientist" position within the DOT.
5. The U.S. DOT should engage more fully with the research community, with a view to leveraging investments in technical and policy areas by other federal departments, as well as by states, industry, and academia.
6. A broad and robust program of basic and advanced research that encompasses the many disciplines relevant to surface transportation should be established.
7. The U.S. DOT should continue its activities that promote knowledge transfer and disseminate research results.
8. The U.S. DOT should establish a relationship with Office of Science and Technology Policy to elevate the visibility of transportation research and its importance on the national science and technology agenda.

9. The many and diverse organizations that make up the surface transportation research community should, both individually and in cooperation with each other, take a proactive approach to sharing the successes of transportation research with a wide range of audiences, including elected officials, other high-level decision makers, and the general public.

The report concludes, "as the U.S. DOT takes steps to build its research capacity and culture, a variety of public, private, academic, and nonprofit organizations should be cooperatively engaged in starting to create that new framework."

Special Report 317, The Essential Federal Role in Highway Research and Innovation [TRB, 2015]

This report examined the Federal Highway Administration's (FHWA) role in fostering national deployment of innovations based on its own research and development and that of other highway research programs. As noted, research, development and technology (RD&T) have fueled innovation across the nation's road network since the early 1950s, when the nation's highway organizations joined forces to develop advances in pavement design. Today, a wide variety of research activities are conducted under the auspices of programs responding to the needs of the numerous jurisdictions responsible for the highway system. Among funding agencies, only FHWA has the resources and ability to conduct long-term research dedicated to highways that explores fundamental relationships.

The report observes that FHWA has invested in exploratory advanced research (in part due to the recommendations of the RTCC). The Exploratory Advanced Research (EAR) program, funded at $11 million annually by Congress during SAFETEA-LU and continued at about $8 million during MAP-21, focuses on research that has a very high potential in return on investment, but is high risk in terms of the possibility of not producing immediately useful results. [FHWA, 2015] The focus areas are: 1) connected highway and vehicle system concepts, 2) breakthrough concepts in material science, 3) human behavior and travel choices, 4) technology for assessing performance, and 5) new technology and advanced policies for energy and resource conservation. RTCC members support this type of research; it is considered fundamental to laying the foundation for a future transportation system based on technology.

The report concludes that FHWA's RD&T role in the future will be critical in two other particularly important ways. FHWA is the lead federal agency in developing and deploying safety applications to provide safety messages between infrastructure and vehicles. The safety

alerts to motorists will depend on FHWA leadership in applying national standards to the variety of traffic signaling systems in use around the country. Second, FHWA is poised to work with states and local governments in deploying the innovations developed through the second Strategic Highway Research Program (SHRP 2), a congressionally authorized 9-year, $223 million federal–state investment. SHRP 2 has developed dozens of innovations to renew aging infrastructure more quickly and cost-effectively, improve the reliability of travel time, provide capacity consistent with environmental protection, and improve safety. The benefits of this significant investment will be delayed or lost if FHWA's central role in fostering deployment is not continued.

The report concludes:

- FHWA is better positioned than are individual states to take a longer view in research and development. This allows the agency to conduct advanced research to harvest breakthroughs in basic research for application in transportation; conduct long-term pavement and bridge experiments to collect necessary data to improve infrastructure performance; and carry out complex, long-term R&D with the automobile industry and infrastructure owners in the connected vehicle initiative, which will help avoid vast numbers of crashes in the future.
- FHWA, with its national perspective, can lead states in the development and transfer of tools and processes that improve safety and system capacity at less cost.
- With its economies of scale and offices in each state, FHWA is uniquely positioned to identify and support the implementation of innovations by states and local agencies. The opportunities for carrying out this role are particularly promising in V2I development and standardization and in deployment of the products from SHRP 2 research. Only FHWA has the national perspective, leadership, resources, and ability to invest for the long term to carry out these responsibilities to the benefit of the nation as a whole.

Madam Chairwoman, these two reports speak toward the need for federal leadership in promoting, fostering, leading and, in some cases, managing research programs that lay the groundwork for technology applications that could fundamentally change the way we use transportation in the future.

I would like to add some personal observations to the conclusions of these two TRB reports. These observations are thus not the product of TRB committees, nor have they been vetted by the peer review process of the National Academies....they are my own thoughts.

I congratulate the Subcommittee on Research and Technology in choosing the subject of this hearing---"Surface Transportation: Technology Driving the Future." I have been in the field of transportation long enough and in a variety of positions to appreciate the impact that technology has had on the way we use the transportation system and how agencies responsible for managing these systems can improve system performance. Who would have guessed 15 years ago that a large number of our citizens would be getting their information on travel options or on the condition of the transportation system from our phones? Who could have foreseen the massive generation of data on trip-making and network usage that comes from advanced sensors and network monitoring technologies? In transportation planning, geographic information systems along with global positioning systems have revolutionized planning analysis approaches.

Looking to the future, what role will "smart" materials play in the provision of future infrastructure? How will vehicle-to-vehicle and vehicle-to-infrastructure technologies influence travel behavior and network performance? What impact will technology applications have in making our vehicles more energy efficient, more sustainable and safer? These are but a few questions we face today in trying to anticipate the impacts of future technologies. These questions become even more important when one realizes that our metropolitan areas and states produce federally-required transportation plans that look 20 to 25 years in the future in order to lay out the capital investments that are needed to satisfy expected demands.

A fundamental characteristic of the nation's transportation research effort, and one that has contributed greatly to the success we have enjoyed so far as a nation in our transportation system, has been the recognition that no one has a "lock" on creativity or transformational ideas. America's industry and service companies have led the way in many of the technology developments that we are now starting to see on the road. In many ways, what happens in the laboratories of the nation's automobile manufacturers or in the research think tanks of companies like Google will probably have more impact on travelers than any other source of innovation. An analogy from the freight sector illustrates this point. The introduction of the 20-foot container in maritime commerce in the 1960s revolutionized the industry, and certainly had a

tremendous impact on the nation's public ports and highway system. Very few in public sector transportation agencies even knew this transformational innovation was occurring. But the impact of the container on road and port capacity, design, operations and associated environmental impacts was long-term, resulting in many research efforts to better understand the implications of this change on transportation system performance.

In other areas, the rich diversity of our nation's universities results in research initiatives that span a range of subjects that will benefit the nation. Many have contributed, and continue to contribute, to advancements in vehicle and network technologies. Others are making major contributions to fuel cell technology or other alternative fuels. Still others are examining the social and economic impacts of changing transportation behavior as well as the consequence to national transportation policy.

And as noted earlier, federal agencies are fostering their own support for transportation technology, and importantly paving the way for these technologies to be understood and used by state, regional and local governmental agencies. In addition, the federal agencies adopt a national perspective on transportation research, focusing on those issues and technology applications that will be of national import.

Time does not allow me to discuss other major participants in the national research effort....state and local agencies, foundations, industry groups, private non-profit organizations, international agencies, and the like. All of this is to say that a national transportation research program cannot really be led or managed by one agency such as the U.S. DOT. However, as noted in *Special Report 313*, the U.S. DOT and its modal agencies have a critical role to play in establishing a research framework that focuses on research of national significance. All of the other participants in research discussed above focus their efforts on topics of specific interest to their organization or group. Industry focuses on research and technology development that will make their products more appealing and cost effective. State DOTs tend to focus on research that will help them in the short run improve their operations. Foundations and special interest groups focus their research on particular topics that have been chosen by their boards (e.g., transportation and public health, system resiliency, and mobility for targeted populations). No one except the U.S. DOT has the interest or motivation to provide national leadership on a relevant and effective research program aimed at national goals.

Note that I used the term "leadership" in describing the U.S. DOT's role. This does not necessarily mean that the U.S. DOT has to do the research itself. The U.S. DOT has a long and successful relationship with the Transportation Research Board, for example, that results in important research products and findings. It also uses universities, national laboratories and consultants to examine other issues of importance to national transportation policy. In some cases, however, such as in the FHWA's Turner-Fairbank Highway Research Center, the federal role in providing national direction and oversight (e.g., in highway sign standards and driver recognition) requires in-house research capability. The Research Center is an excellent example of the research partnerships among federal and state agencies, universities, and private industry that will characterize successful federal transportation research leadership in the future.

My key observations with respect to a national surface transportation research program are:

1. The U.S. DOT has a critical role in establishing a research framework that guides its own agencies' research activities as well as those who are in its area of responsibility (e.g., the University Transportation Centers program).
2. The framework should recognize that many other government and private industry participants are conducting research for their own purposes that could have significant impact on future transportation performance.
3. The DOT's research portfolio should include a mix of basic and applied research, similar to what is done by the FHWA. The research portfolio should focus on issues of national significance and "fill in the gaps" on impacts and public policy implications of technology development that are not being addressed by others.
4. To the extent possible, look into the future and anticipate the technologies and societal trends that will have important consequences on transportation system performance. These are the topics to focus on.
5. Provide seed money for the "little guy." Transformational ideas and concepts often do not fit into the norm of today's common understandings. Look at the proliferation of apps that are constantly changing how we obtain and use information. Big research organizations do not have a lock on innovation. Similar to FHWA's Exploratory

Advanced Research Program, the research portfolio should provide opportunities for high-risk, high payoff research.

6. Base research program development on peer review. The peer review process is designed to develop a research portfolio that has the best chance to "make a difference." The Transportation Research Board and National Science Foundation are excellent examples of how successful peer review works. Especially for applied research where the results are directly relevant to those who fund the projects, TRB's Cooperative Research Programs are an excellent model.

Madam Chairwoman and members of the Committee, thank you for this opportunity to present my ideas. As the Committee has noted, technology is "driving" our transportation future. I would suggest that research and development are "driving" technology development, and it is thus in the national interest to support, foster and encourage the creativity that lays at the foundation of our technology future.

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Qualifications

Dr. Michael D. Meyer is Senior Advisor, Parsons Brinckerhoff, Inc. From 1988 to 2012, he was a Professor of Civil and Environmental Engineering and Director of the Georgia Transportation Institute at the Georgia Institute of Technology. From 1983 to 1988, Dr. Meyer was Director of Transportation Planning and Development for Massachusetts where he was responsible for statewide planning, project development, traffic engineering, and transportation research. Prior to this, he was a professor in the Department of Civil Engineering at M.I.T.

Dr. Meyer has written over 200 technical articles and has authored or co-authored numerous texts on transportation planning and policy, including a college textbook for McGraw Hill entitled *Urban Transportation Planning: A Decision Oriented Approach.* He was the author of *Transportation Congestion and Mobility: A Toolbox for Transportation Officials,* a book that focuses on transportation actions that can be implemented to enhance mobility. Dr. Meyer was one of the first researchers to study performance measures and their use in transportation planning. He is an active member of numerous professional organizations, and has chaired committees relating to transportation planning, performance measures, public transportation, freight, environmental impact analysis, transportation policy, and intermodal transportation. In 2006, he was Chairman of Executive Committee of the Transportation Research Board.

Chairwoman COMSTOCK. Perfect. And I now recognize Dr. Smith for five minutes.

TESTIMONY OF DR. BRIAN SMITH, DIRECTOR, CENTER FOR TRANSPORTATION STUDIES, UNIVERSITY OF VIRGINIA

Dr. SMITH. Chairwoman Comstock, Ranking Member Lipinski, and Members of the Committee, thank you for holding this hearing and inviting me to testify today. My name is Brian Smith, and I am the Director of the University of Virginia Center for Transportation Studies. I appreciate the Committee's focus on the role of the federal government in supporting research to tackle emerging transportation challenges.

UVACTS leads a wide range of research and education activities directly supporting local, state, and federal agencies, as well as the private sector. My testimony today will focus on the work of CTS in our new Mid-Atlantic Transportation Sustainability University Transportation Center, or MATS UTC for short, and how federal, state, and local engagement with, and support for, university research has improved the safety, efficiency, and sustainability of our nation's surface transportation system.

UVA has a long history of working closely with local and state agencies, such as the Virginia Department of Transportation, or V–DOT, to deliver applied research that advances their missions. In addition, we also develop the future leaders of the transportation industry and train over 2,000 V–DOT and local agency professionals annually to take full advantage of rapidly changing technology. To complement the applied research, basic research is essential to create the advances and develop technologies that sustain an efficient, reliable, and cost-effective system. In particular, a strong federal transportation research program is crucial as the research community seeks to develop new technologies that take advantage of rapid advances in fields such as materials and information technology.

For many states, including Virginia, the Federal University Transportation Centers, or UTC Program, has played a key role in enabling a comprehensive program that balances both short term applied research with higher risk, higher reward basic research focused on emerging challenges. The UTC program brings together federal and state resources to address critical regional needs that limited state resources cannot address alone. The program is a small, but highly leveraged federal program that successfully maximizes the support.

I will now change and discuss the new MATS UTC, which has expanded our research and education capabilities at UVA. MATS UTC began operation last July, and supports the surface transportation community in the United States, with a focus on the Mid-Atlantic region. The objective of our work is to improve the environmental sustainability of surface transportation services. Our partners in the UTC are Virginia Tech, Old Dominion University, Marshall University, Morgan State University, and the University of Delaware. Like many UTCs, the MATS UTC program focuses on research, technology transfer, undergraduate and graduate education, training of practicing transportation professionals, and out-

reach to introduce opportunities in surface transportation and STEM fields to the K–12 students, with a focus on traditionally underrepresented groups.

We've organized the MATS UTC program to bring together the region's researchers to work on teams to tackle complex problems. A key component of our program lies in soliciting proposals to competitively award funding to support multidisciplinary research that addresses the needs of the region and nation. Our research is reviewed by national experts in a peer review fashion. Our multilevel research program is focused on five critical areas, sustainable freight movement, coastal infrastructure resiliency, energy efficient urban transportation, enhanced water quality management, and sustainable land use practices. USDOT is integral to the operation of MATS UTC, both through the funding it provides, and through close coordination with our team. MATS UTC also works closely with local and state transportation agencies to ensure that our research is responsive to local needs.

Outside of MATS UTC, UVA continues to conduct research for the future surface transportation system. For example, UVA CTS supports the USDOT as it invests in development of connected vehicle applications, which you heard about a bit already, to provide connectivity between and among vehicles, infrastructure, and wireless devices, enabling safety, mobility, and environmental benefits. Our research is focused on using technology to allow DOTs to meet their missions more effectively, and at lower costs. An example is a recent research project on pavement roughness measurement to support roadway maintenance. This work we did provides the potential for V–DOT to improve their data collection, while also saving about $2 million a year in monitoring costs. UVA CTS also frequently interacts with private sector to involve companies in applied research, and to support rapid implementation of results. More detailed examples of technology transfer in our research is provided in my written testimony.

UVA CTS is proud to have contributed to the development of transportation technology, and to have developed leaders in the transportation industry. Thanks to federal investment in research, in particular long term support of the critical UTC program, the country is well positioned to make our transportation system safer, more efficient, and sustainable. I appreciate the opportunity to provide testimony to the Committee, and I am happy to answer questions later. Thank you.

[The prepared statement of Dr. Smith follows:]

U.S. Surface Transportation: Technology Driving the Future
June 12, 2015 Hearing

Congress of the United States
House of Representatives
Committee on Science, Space, and Technology
Subcommittee on Research and Technology

Testimony of Dr. Brian L. Smith, P.E.
University of Virginia
Center for Transportation Studies

The University of Virginia Center for Transportation Studies (UVA CTS)

My name is Dr. Brian Smith and I am the Director of the University of Virginia Center for Transportation Studies (UVA CTS). UVA CTS is one of the nation's leading university centers focused on research and education to improve surface transportation. I appreciate the Committee's focus on the important role the federal government plays in supporting research to tackle emerging challenges in transportation as well as the opportunity to speak today.

Currently, UVA CTS is comprised of 12 affiliated faculty across the university, concentrated in the Department of Civil and Environmental Engineering, 10 staff members, and 45 graduate students. The center leads a wide range of research and education activities – directly supporting local, state, and federal agencies, as well as the private sector. UVA has a close working relationship with the US Department of Transportation (USDOT) leading the Mid-Atlantic Transportation Sustainability University Transportation Center (MATS UTC). My testimony today will focus on the work of CTS and MATS UTC, our relationship with both USDOT and state and local transportation entities, as well as examples of the impact university research has had on improving the safety, efficiency, and sustainability of our surface transportation system.

It is important to note that basic research – efforts with high risk and high reward –is essential to the development of technologies that allow for significant advances that change the lives of our citizens. Supporting this type of research has traditionally been a federal role, and it is becoming more critical as advances in fields such as information technology occur at an even more rapid pace. A strong federal transportation research program is crucial to sustaining an efficient, reliable, and cost-effective transportation system. Advancements in materials and technologies allow agencies to build, maintain, and operate the surface transportation system at a lower cost, while also reducing losses to the nation's economy due to urban congestion.

UVa has a long history of working closely with local and state transportation agencies to deliver research that advances their missions. The focus on research and education in surface transportation began at UVA in the 1940's, when the university, in partnership with the Commonwealth of Virginia's Department

of Highways, established the Virginia Council of Highway Investigation and Research on the UVA grounds in Charlottesville. This partnership, which today is known as the Virginia Center for Transportation Innovation and Research (VCTIR), still serves as one of the most successful university-state transportation partnerships in the country. It has also shaped the university component, UVA CTS, to focus on research and education on surface transportation infrastructure that is directly relevant to state, local, and national transportation needs.

The United States Surface Transportation Act of 1987, which called for the nationwide establishment of U.S. Department of Transportation (USDOT) University Transportation Centers (UTCs), triggered a significant evolution of the transportation program at UVA, resulting in the formal establishment of CTS. The federal UTC program has played a key role in allowing UVA CTS to evolve from a program that focused exclusively on Virginia-focused, short-term efforts that lead to immediate incremental improvements, to a more comprehensive program that balances short-term research, with higher-risk, higher-reward research that addresses emerging challenges in surface transportation, a change that has been replicated in many other states home to UTCs.

In order to provide a clear example of the relationship between UVA CTS and the USDOT in research, development, and technology, as well as to illustrate the important interrelationship between the university, federal and state government in surface transportation research, the next section will provide a description of the Mid-Atlantic Transportation Sustainability University Transportation Center (MATS UTC).

MATS UTC

UVA CTS has been a supporting member of multiple UTCs since the national program was established in 1987. Recently, however, UVA CTS has taken a major step forward in participation in USDOT research efforts by leading the successful proposal for the establishment of the MATS UTC in 2014. MATS UTC began operation last July as the center responsible for supporting the surface transportation community in Virginia, West Virginia, Maryland, Delaware, Pennsylvania, and the District of Columbia (Federal Region 3), with an emphasis on improving the ability to provide surface transportation services in a sustainable manner. Our partners in the MATS UTC are Virginia Tech, Old Dominion University, Marshall University, Morgan State University, and the University of Delaware.

The MATS UTC program focuses on research, education of future transportation professionals at the university level, training of practicing transportation professionals, and outreach to introduce opportunities in surface transportation to K-12 students, with a focus on groups traditionally under-represented in our industry. Our research program is focused on 5 areas directly related to sustainability in surface transportation, addressing all modes:

- Sustainable Freight Movement – Freight movement is particularly critical in the mid-Atlantic region given the large port facilities, critical trucking routes, extensive rail network and

inland waterways. While the movement of freight plays a key economic role, the impact of freight movement on the environment in the region is significant and is being directly addressed.

- Coastal Infrastructure Resiliency – The majority of the population in the mid-Atlantic region lives in coastal areas that are directly impacted by the effects of climate change – particularly sea-level rise and extreme weather events. The MATS UTC conducts research to better understand risks and identify innovative adaptations.

- Energy Efficient Urban Transportation – The I-95 Urban Corridor in the mid-Atlantic region experiences extreme congestion. According to the Texas Transportation Institute's Urban Mobility Report, the Washington D.C. region is the most congested in the nation, with Philadelphia also in the top-10. The MATS UTC focuses research on energy efficient, environmentally sound methods to address this urban congestion problem.

- Enhanced Water Quality Management - Given the mid-Atlantic's coastal location and important inland waterways, the management of stormwater on transportation facilities is particularly important to protect watersheds. Regional transportation agencies are particularly interested in looking beyond meeting minimum regulations to developing more sustainable water quality management practices.

- Sustainable Land-use Practices – The mid-Atlantic region is made up of an incredibly diverse mix of densely populated urban areas, sparsely populated forested regions, and brownfield sites, among others. One-size-fits-all land use policies and practices simply will not work. The center investigates practices that promote environmental sustainability for all of the region's areas.

We organize the MATS UTC program to bring out the best research from the region's researchers and encourage teams to organize to tackle complex problems. Half of the center's research funds are awarded based on competitively selected proposals. The proposals are reviewed by national experts as well as the MATS UTC advisory panel to ensure they are scientifically excellent, and that they address needs of the region and nation.

The vast majority of research projects conducted by the center include 2 or more investigators from multiple center universities. This reflects the fact that the complexity of modern challenges in surface transportation requires interdisciplinary teams – with a wide geographic perspective.
It is very important to point out that, as part of its research program, and in other center activities, MATS UTC plays a very important role in helping the country develop a workforce with a strong Science, Technology, Engineering and Math (STEM) foundation. All of the research projects in the MATS UTC involve students at the undergraduate and graduate levels. For example, last week, UVA welcomed nine MATS UTC summer interns to participate in the research program. These students come from universities across the country and are primarily individuals from groups traditionally underrepresented

in STEM fields – for example – eight of the nine students are women. In addition, through the MATS UTC program, faculty, staff, and students at UVA CTS are reaching out to middle and high school students to provide them with hands-on engineering experiences to show them the excitement and opportunity they will find in STEM fields.

Federal Involvement in MATS UTC

USDOT is integral to the operation of MATS UTC, both through the funding it provides and the through close coordination with our team. Federal involvement in the MATS UTC began with the clear and ambitious goals articulated in the grant solicitation. The solicitation states "The purpose of these Centers is to advance U.S. technology and expertise in the many modes and disciplines comprising transportation through the mechanisms of research, education, and technology transfer; to provide a critical transportation knowledge base outside the US DOT; and to address vital workforce needs for the next generation of transportation leaders." The solicitation further requires that a center establishes a focal area that aligns directly with one of the US DOT Strategic Goals. The stated purpose of the UTC program, along with the national goal of environmental sustainability – selected as the focus of MATS UTC, drive every activity of the MATS UTC.

The MATS UTC works closely with the US DOT grant manager assigned to the center. Our center delivers detailed Program Progress Performance Reports every 6 months. We also meet with US DOT UTC Program leadership twice a year as part of national Council of University Transportation Center meetings. Beyond this more formal method of federal interaction and involvement in the MATS UTC, our center faculty and staff are active in working with federal officials to learn more about federal needs and ways in which MATS UTC can make a difference. For example, UVA CTS faculty, staff, and students work regularly with federal and contract staff at the Federal Highway Administration (FHWA) Turner-Fairbank Highway Research Center. In fact, a UVA PhD student is currently spending the year on-site at the Turner-Fairbank Highway Research Center's Saxton Laboratory to contribute to federal projects, and to utilize rich data sources made available through the federally sponsored Connected Vehicle Safety Pilot being conducted in Ann Arbor, Michigan.

State Involvement in MATS UTC

MATS UTC works closely with local and state transportation agencies in the mid-Atlantic region to ensure that our research is responsive to local needs. In fact, one of the primary reasons that UVA CTS stepped forward to lead the MATS UTC was that transportation officials in Virginia saw a significant benefit in the Commonwealth of Virginia playing a large role in the regional UTC. The federal UTC program requires matching funds in an amount at least equal to the US DOT grant amount. In Virginia, the Virginia Department of Transportation (VDOT) provides the majority of matching funds required by the UTC program. VDOT considers this an effective way to leverage its resources to conduct a more comprehensive research program.

In order to maximize the benefit of Virginia's involvement in the MATS UTC, the member universities from Virginia (UVA, Virginia Tech, and Old Dominion University) meet regularly with VDOT research staff to identify and scope projects that meet the center's focus, and also address critical needs within Virginia. These projects are monitored by VDOT staff, and results are presented to VDOT's existing research advisory committees. Simply put, the MATS UTC program allows VDOT to address critical needs that it would be unable to given limited state resources. In addition, this strong level of state investment and involvement ensures that federal research investments are used to directly address the needs of the owners and operators of the nation's transportation infrastructure.

MATS UTC Advisory Board

As evident above, the challenge of crafting the MATS UTC program is considerable, given the needs to address federal goals and objectives and support VDOT and other member states' needs, all while involving a wide range of faculty from 6 campuses. In order to support this, the MATS UTC has established an active advisory board to identify activities that have the highest significance from a regional and national perspective. This board has been established with national experts as well as regional leaders at all levels of government, and supporting all modes of surface transportation, to ensure that the center can meet its dual charge of advancing national environmental sustainability goals, as well as serving as a key resource to the surface transportation community in the mid-Atlantic region.

The panel meets regularly, both in person and via conference call, to advise MATS UTC leadership on research, education, and outreach activities. It also provides an importance mechanism to support technology transfer. Members of the advisory board are tasked to work with their respective organizations to move results of MATS UTC research to direct implementation. In addition, all MATS UTC research projects include a technology transfer plan. In order to develop these, MATS UTC researchers must work with transportation professionals throughout the course of the project to identify specific ways that research results can be incorporated in future transportation initiatives.

Impact of UVA CTS

UVA CTS and MATS UTC have a major impact at all levels of government as well as in the private sector. The impact is described further below:

Commonwealth of Virginia – Through its partnership with VCTIR, UVA CTS conducts many applied research projects for VDOT. Given VDOT's mission to build and maintain the transportation system, it stresses the importance of direct implementation of all research. Thus, the projects that UVA CTS conducts using VDOT funding tend to be focused on important incremental improvements to practice. These are very valuable to the state and have resulted in direct improvements in efficiency and safety.

In addition to research, UVA CTS plays a key supportive role to VDOT through our training program. The center delivers 115 short courses per year, training 2,250 VDOT and local agency professionals. Given the rapid pace of change in technology in transportation, it is essential that practicing professionals are provided with the opportunity to gain knowledge to effectively apply this technology.

US DOT – The impact of the MATS UTC research program, and its direct alignment with federal goals, is well documented above. Beyond this, UVA CTS research has played a critical role in advancing surface transportation in the United States through other UTC programs, and in other collaborative research with federal agencies (as described in the section below, "Example of UVA CTS Research Advancing Surface Transportation"). Furthermore, UVA CTS, like other university programs, plays the critical role of developing future leaders in transportation. Our alumni currently hold key leadership positions within USDOT and these leaders cite their UVa training as essential to their current success. For example, at a recent webinar presented by UVA CTS, Pamela Kordenbrock, FHWA Tennessee Division Administrator, spoke with students about "Careers in Transportation." In her discussion, she cited her experience as a UVA graduate student conducting research in the UTC program as a key element exposing her to, and preparing her for, a career in surface transportation.

Private Sector – As with VDOT, and USDOT, UVA CTS plays an important role in preparing students to enter private sector positions in surface transportation. In addition, UVA CTS frequently interacts with the private sector to involve companies in applied research, and to disseminate results to support more rapid implementation of results. For example, in recent years UVA CTS worked closely with a Virginia-based technology firm to help them incorporate advances in transportation data analysis and management, developed in our Smart Travel Laboratory, into their transportation management system products. This has allowed the firm to improve their competitiveness and better support their transportation agency customers.

Example of UVA CTS Research Advancing Surface Transportation

UVA CTS has been proud to play a major role in research that seeks to apply advances in information technology to surface transportation. A primary example can be seen in navigation smartphone "apps" that our citizens use routinely as travelers – whether they are pedestrians, drivers, or utilizing transit.

We have become accustomed to seeing roads colored red, yellow, or green on our navigation apps, depending on the level of congestion. How are the roadways colored red/yellow/green? Fifteen years ago, the only viable way to quantify traffic conditions was to use sensors to measure the speed of cars that pass by. The most widely used technology, inductive loop detectors, were embedded in the pavement. Given this location, the detectors were notoriously unreliable. They were also expensive to install and maintain. As a result, transportation agencies could only afford to install them on major roadways, often rather widely spaced. In the late 1990's, cellular phones began to become popular. At this time, UVA CTS, in partnership with FHWA and VDOT, began a research and demonstration project that sought to use cellular phones as a means to collect traffic information. The basic concept was that

the phones could be considered as "probes" moving through the transportation network, providing valuable data on average speeds of the vehicles that carried them.

Beginning with this project, and progressing over the next decade, UVA CTS researchers explored ways to derive traffic information from mobile probes. There were many challenges. For example, how do you filter out a traveler who is stopped at a drive-through for a hamburger vs. someone sitting in a traffic jam? Another issue to address was how much data is enough to effectively estimate traffic conditions? The results of our work were published in the open literature and presented at major conferences. Over the years, there was steady progress in the underlying research (by UVA CTS and others), and consumers have moved from cellular "flip" phones to smartphones. Today, there are American companies that sell traffic data services to transportation agencies and other private firms, based on this technology. And, as a result, travelers have access to detailed navigation guidance, literally, in their back pockets. This was made possible by the partnership of federal investment in surface transportation research and active university transportation research programs.

Today, UVA CTS continues to conduct research that will serve as the foundation for advances in the future surface transportation system. A good example of this is in the area of connected vehicles. US DOT is investing in development to support connected vehicle applications which provide connectivity between and among vehicles, infrastructure, and wireless devices to: enable crash prevention, enable safety, mobility and environmental benefits, and provide continuous real-time connectivity to all system users. Working with our partners at Virginia Tech in the Connected Vehicle/Infrastructure University Transportation Center (CVI-UTC), we have conducted research to develop prototype connected vehicle applications that allow transportation agencies to better serve the traveling public. UVA CTS is also providing technical leadership for the Connected Vehicle Pooled Fund Study, which has been established by a consortium of 14 transportation agencies (primarily local and state agencies, including FHWA). It is expected that the research conducted in these programs will provide the foundation to demonstrate the benefits that infrastructure providers will realize from connected vehicles, and pave the way for a more connected system in the years to come.

A specific example of a UVA CTS connected vehicles' research project that demonstrates the cost savings that surface transportation research enables is our work investigating means to collect pavement roughness data using smartphones. Today, transportation agencies must "drive" their entire roadway network to directly measure pavement roughness using bumper-mounted laser scanners. Collecting this data is time-consuming and costly – for example, it requires a roughly $2 million annual investment in Virginia, and this does not allow for all minor roadways to be measured. However, the data is essential to make informed decisions on pavement maintenance. This is especially important when you consider that pavement makes up a substantial portion of VDOT's $2 billion annual maintenance budget. Our research team has found that the accelerometers included in smartphones can be used to derive good measurements of pavement roughness. We have developed data analysis algorithms, and conducted field tests to conclude that this example of a connected vehicle application can be used to provide more timely and more comprehensive pavement roughness data, while allowing for a considerable reduction in data collection costs.

Conclusion

As we have seen in the past, technology will drive the future of surface transportation. UVA CTS is proud to have contributed to the development of transportation technology and to have developed leaders in the transportation industry. Thanks to federal investment in research, and, in particular, long-term support of the UTC program that serves as a key foundation of UVA CTS, along with numerous other university transportation programs, the country is well positioned to continue to improve technology to make our surface transportation safer, more efficient, and sustainable.

I appreciate the opportunity to provide testimony to the Committee and am happy to answer any questions.

Brian L. Smith, PhD, PE, F.ASCE

Brian L. Smith is Professor and Chair of the Department of Civil and Environmental Engineering at the University of Virginia. Dr. Smith is also the Director of the University's Center for Transportation Studies. He has been a member of the University of Virginia faculty since 1998 and is a registered professional engineer in Virginia. Dr. Smith received his BS in Mechanical Engineering from Virginia Tech, his MS in Systems Engineering from the University of Virginia, and his PhD in Civil Engineering from the University of Virginia.

Dr. Smith was elected as a Fellow of the American Society of Civil Engineers (ASCE) in 2009, and is also a recipient of the 2006 ASCE Huber Research Award, 2004 Council of University Transportation Center's New Faculty Award, an National Science Foundation (NSF) CAREER award, an Eno Transportation Leadership Fellow, a 2001-2002 University of Virginia Teaching Fellow, and a selected participant in the 2000 NAE Symposium on Frontiers of Engineering. He is an associate editor of the ASCE Journal of Transportation Engineering. He is also the author of a chapter on Transportation Management in the text "Intelligent Transportation Primer."

Dr. Smith has taught courses on transportation engineering, surveying, geographic information systems, and construction engineering. His primary research interests are in transportation systems engineering, focusing on sustainability, intelligent transportation systems (ITS), advanced transportation management and connected vehicles. Dr. Smith has published ITS-related research in the areas of cooperative systems, probe-based traffic monitoring, statistical modeling, traffic flow theory, data mining, geographic information systems (GIS), and artificial intelligence.

Prior to joining the University of Virginia faculty in 1998, Dr. Smith was a Senior Research Scientist at the Virginia Transportation Research Council (now known as the Virginia Center for Transportation Innovation and Research), where he helped establish the Virginia Department of Transportation's (VDOT's) ITS program, and led VDOT's ITS research program.

Chairwoman COMSTOCK. Thank you. And I now recognize Mr. Owens for five minutes.

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

Mr. OWENS. Okay. Thank you, Chairwoman Comstock, Ranking Member Lipinski, and Members of the Subcommittee on Research and Technology, for giving me the opportunity to testify today on behalf of Delphi. As Chief Technology Officer, I'm responsible for Delphi's global engineering organization, our innovation strategies, and our advanced technologies. As a leading global supplier of electronics and technologies for automotive, for commercial vehicles, and other market segments, we invest more than $1.7 billion annually into engineering development initiatives, and employ approximately 5,000 people in the U.S.

Like the Science Committee, Delphi has a long history of dedication to technological innovation, culminating this April with the first autonomous vehicle cross-country drive. Are we okay to keep going? Okay. So let me pause to show a short video that highlights some of the Delphi technologies that made it possible. Okay. Well, that was a very short video. So if we'd had a chance to see the video, what you would've seen would've been a replay of our coast to coast drive that we did back in April, so—we outfitted an Audi Q5, if you will, drove 3,400 miles through 15 states, went from San Francisco to New York City. We had a car that operated autonomously 99 percent of the time.

So—we had a bunch of film clips in there of the car going through the variety of states across the United States. Some of the things that it encountered, like some of the bridge structures, the roundabouts, the lane markings that were different state to state. So there was a little bit of color on that, but the—for us, we installed a broad suite of our active safety technologies on a—like I said, a 2014 Audi Q5. We had the latest technology. It included radars, cameras, LIDARs, V2X, GPS, and driver state monitoring. In driver state monitoring, which allows the vehicle monitor the availability of the driver in situations where a takeover may be necessary. Looks like we——

Chairwoman COMSTOCK. I think it worked. Yeah. No, we'd love to see it, so——

[Video shown.]

Mr. OWENS. So there's some narration that went with this, basically detailing that the sensors acts like your eyes and ears, and your touch as a human being. It imbeds into the infrastructure of the vehicle, makes the same decisions that you would make as a driver, and we were able to do it 99 percent of the time autonomous. So one of our primary lessons from the success of this drive is that we've—we have available today, in the consumer marketplace, technology that includes forward collision warning, collision imminent braking, lane departure warning, and blind spot detection that, if more broadly adopted, will dramatically reduce deaths and injuries on our roads. Today's active safety technologies operate well enough to drive a car on its own 99 percent of the time,

and these technologies, when paired with a driver, can address one of the greatest causes of premature deaths, and that's traffic accidents.

Through consumer-based adoption of active safety technology 11,000 lives can be saved annually without a technology mandate, without a broad new program, and without regulatory requirements. Vehicle deaths in the United States have declined with widespread adoption of passive safety technologies such as seat belts and airbags, but progress towards further death and injury reduction has stalled. We still have 33,000 deaths annually in the United States, and over 200,000 serious injuries each year on our roadways. So government and industry groups have studied the benefits of these technologies for well over a decade. A study by the Insurance Institute for Highway Safety, the IIHS, states that a 31 percent reduction in deaths is possible. So, once again, that's more than 11,000 lives saved per year with full deployment of active safety systems throughout the vehicle fleet.

So, in conclusion, the driving public wants vehicles with improved safety features. As a cross country drive demonstrated anew, the technologies are currently available; however, it's difficult for consumers to understand their value. And a key consumer awareness tool is DOT's New Car Assessment Program, or NCAP, which includes a five star rating on all new vehicle stickers. Already both the insurance industry, through its IIHS Safety Pick Plus Program, and the European Union, through the Euro NCAP, incorporate active safety into their safety ratings.

Though today, DOT's NCAP does not include active safety and five star rating system, and I feel the DOT should amend NCAP to require a five star rating in the five star rating system. It should include active safety features like collision avoidance technology. So this week Representatives Rokita and Blumenauer introduced the Safety Through Informed Consumers Act, or STICERS, which requires NHTSA to incorporate active safety into their safety rating system within a year. The legislation provides the best path forward for wide scale adoption of active safety by giving consumers information in a form they can use, and to which the market will respond.

The sooner we increase consumer awareness, the sooner we can lower fatality rates, the sooner we move towards cars that can drive safely today, with a driver behind the wheel, and in the future, maybe on their own. So, again, thank you for the opportunity to address the Subcommittee, and I look forward to questions.

[The prepared statement of Mr. Owens follows:]

Written Testimony of
Jeffrey J. Owens, Chief Technology Officer - Delphi Automotive

House Committee on Science, Space, and Technology
Subcommittee on Research and Technology
Hearing on
June 12, 2015

DELPHI

Thank you, Chairwoman Comstock, Ranking Member Lipinski, and Members of the Subcommittee on Research and Technology, for giving me the opportunity to testify today on behalf of Delphi.

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

As a leading global supplier of electronics and technologies for automotive, commercial vehicle and other market segments, we invest more than $1.7 billion annually into engineering development initiatives. In the U.S., Delphi operates major manufacturing facilities, technical centers, and/or administrative facilities in California, Michigan, Ohio, Indiana, New York and Mississippi that employ approximately 5,000 people. Delphi's technology portfolio places us at the center of vehicle evolution and innovation, making products smarter and safer as well as more powerful and efficient.

Given our proven expertise with market-leading original equipment manufacturers (OEMs) around the world and our broad automotive systems capabilities, we welcome the invitation to testify.

Like the Science Committee, Delphi has a long history of dedication to technological innovation. We have produced a long-line of innovative firsts dating back over a century. In 1911, Delphi produced the first electric starter; in 1936, the first in-dash radio, and the first integrated radio navigation system in 1994. In April of this year, Delphi performed the first autonomous vehicle cross-country drive.

Today I will give you an overview of the cross-country drive and discuss some of the lessons learned from the trip. I will discuss the technologies that made the trip possible, in particular active safety technology that is not only vital to the eventual success of autonomous vehicles but is available in the marketplace and saving lives today.

I will also discuss some of Delphi's and the Department of Transportation's current research priorities and actions the federal government could take to set the stage for autonomous vehicles in the future.

I will begin with a short video showing the cross-country drive and highlighting some of the Delphi technologies that made it possible.

Written Testimony of
Jeffrey J. Owens, Chief Technology Officer - Delphi Automotive

[1 minute video clip]

Description of cross-country drive

Delphi made history by completing a 15 state, 3,400 mile journey from San Francisco to New York City with a car that, 99 percent of the time, was driving without human input. The drive took place during daylight hours and included an engineer behind the wheel with the ability to take-over if the car encountered a situation the vehicle could not clearly navigate on its own. It is a testament to the technology that we encountered very few such situations. Again, 99 percent of the drive required no additional driver input.

Description of onboard technologies associated with drive

Delphi installed a broad suite of our active safety technologies on a 2014 Audi SQ5. The vehicle was equipped with the following technologies:

- **Radar and vision systems**: Our vehicle uses a combination of short- and long-range radars—Electronically Scanning Radars (ESR) and Short Range Radars (SRR) in a 360° configuration. The ESRs specialize in long-range sensing functions, such as adaptive cruise control and cross traffic detection.

- **Vision:** The vehicle is equipped with cameras for vision-based perception: an ADAS camera, a high-resolution color camera, and an infrared camera. The ADAS camera is used for pedestrian, lane, and vehicle detection. The high-definition color camera is used for traffic light detection and the infrared camera provides redundancy for pedestrian and vehicle detection.

- **Lidar:** As opposed to the externally high-mounted, spinning lidars used in many other autonomous platforms, our vehicles use a fused system of lidars which are integrated around the periphery of the vehicle. This approach enables 360 degree coverage, while preserving the aesthetics of the vehicle. The lidars generate a high-resolution point cloud that is helpful for general object detection; particularly in densely packed urban environments. Each lidar is paired with one of our ESRs, which allows us to effectively fuse radar and lidar data.

- **Sensor fusion:** The perception system on Delphi's automated vehicles leverages our experience with multiple sensors through highly complex fusion. Radar, vision and lidar-based sensors each have unique strengths and weaknesses; fusing these sensors allows them to compensate for one another and provide an accurate picture of the driving environment with robust detection of vehicles, pedestrians, and general objects.

- **V2X:** Delphi's automated platforms make use of dedicated short-range communication (DSRC) for collaborative communication with infrastructure, such as traffic lights (V2I), other vehicles (V2V) and pedestrians (V2P). V2X communications provide redundancy that is especially useful in urban environments with numerous traffic signals, vehicles, and pedestrians.

- **Localization System:** Delphi uses precision GPS information for safely traveling through the driving environment; even when the infrastructure is marginal (e.g. poor lane markings). In situations with poor GPS reception, such as tunnels and urban canyons, our vehicles make use of a highly accurate IMU (inertial measurement system) for dead reckoning. Additionally, the environmental sensors on the vehicle can pick out key features of the environment for map-matching.

- **Drive-by-wire system:** The drive-by-wire system featured in Delphi's automated driving platforms is implemented in a manner that preserves the function of the production vehicle's steering and drivetrain. When manually operated, the vehicle drives exactly as a production vehicle would. When auto mode is engaged, the automated system uses the same vehicle input interfaces as a human driver, which allows passengers to directly see and feel how the vehicle is behaving. The automated driving system is completely separable from the stock system, which allows the driver to instantaneously assume full control of the vehicle at any time.

- **Driver Monitoring:** Understanding the state of the driver is a vital aspect of automated driving. Delphi's automated driving platforms are equipped with state-of-the-art driver state sensing systems, which allow the vehicle to monitor the availability of the driver in situations where a takeover may be necessary. If the driver is found to be unavailable, the vehicle is capable of coming to a stop until it is safe to proceed.

- **Multi-domain controller:** As these systems become more complex and computing technologies become more capable and with much higher processing power, it enables re-architecting the vehicle. This creates a need for multi-domain control where the architecture can be optimized for control, functional safety and complex sensor fusion systems for automation.

Some of these same technologies are available on cars today in consumer options such as Forward Collision Warning with Collision Imminent Braking, Lane Departure Warning, and Blind Spot Detection.

A key component of ensuring the vehicle could function was the integration of software with the hardware. Vehicle technology is increasingly software based and dependent. If you don't get the software right, the car will not function.

The vehicle performed flawlessly. It was able to make complex decisions necessary to drive safely across the country while, unlike human drivers, remaining alert the entire time.

Delphi engineers gathered more than two terabytes of data during the trip, including computer data and video footage of everything "seen" by the car. A couple of quick observations from our trip:

- Our vehicle was particularly cautious when approaching semi-trucks in adjacent lanes. In situations where our vehicle passed such large trucks, it remained in the center of its lane

rather than veering slightly to the far side of the lane. Engineers were able to tweak the programming to address this scenario.

- Artificial intelligence gaps remain that require our attention – such as "which vehicle has the right of way" upon approaching a four-way stop when one vehicle nudges forward to alert the other driver of its intention.
- We noted that HOV lanes are perfect for automated driving since lane markers are very clear. The idea of a dedicated lane may prove useful as automated cars become more mainstream.

Even with the use of radar, cameras, and other sensors, aggressive or speeding drivers can quickly appear during a lane-change, compromising the effectiveness of these technologies.

Lessons learned from drive -- Active safety ready and needed

One of the primary take-a-ways from the success of the cross-country drive is that we have available today in the consumer marketplace technology that, if more broadly adopted, will dramatically reduce deaths and injuries on our roads. Specifically, today's active safety technologies, also known as Advanced Driver Assist Systems (ADAS), operate well enough to drive a car on its own 99 percent of the time. These technologies, when paired with a driver, can address one of the greatest causes of premature deaths – traffic accidents.

Need for broader adoption of active safety

Every 30 seconds, there is a vehicular fatality somewhere in the world. That equates to 1.2 million people who die worldwide each year. It's a tragedy, and can be prevented. According to the World Health Organization, less than 20 years from now traffic injuries are projected to be the fifth leading cause of death worldwide – surpassing HIV/AIDS, cancer, violence, and diabetes. The impact is not just on lives lost, but on our global economy. Here in the United States, vehicle fatalities have declined with the use and widespread adoption of passive safety technologies such as seatbelts and airbags. However, progress toward further fatality and injury reduction has stalled, allowing over 33,000 fatalities annually in the US, and more than 200,000 serious injuries each year on our roadways. Additionally, vehicular crashes continue to be the number one cause of fatalities for people ages 4 to 34, with over 90 percent of accidents caused by driver error. The financial impact is also staggering, with one study estimating the total annual cost of road crashes in the United States alone to be over $231 billion.

Active safety technologies are the key to reducing accidents, injuries, and fatalities on our roadways. Government and industry groups have studied the benefit potential for these technologies for well over a decade. In particular, a recent study by the Insurance Institute for Highway Safety (IIHS) states a 31% reduction in fatalities is possible with full deployment of active safety systems across the vehicle fleet, namely, Forward Collision Warning with Collision Imminent Braking, Lane Departure Warning, and Blind Spot Detection. This reduction amounts to a potential savings of over 11,000 U.S. lives per year.

These technologies are not just life savers, but, as demonstrated by our cross-country drive, the building blocks for the autonomous cars of the future. A key element of broader penetration of active safety technologies in the US fleet is consumer awareness and demand.

How the government can help -- Modernize NCAP

The driving public is very interested in buying cars with improved safety features. There are numerous technologies currently available, but it is relatively difficult for consumers to decipher the value of various safety technologies. One of the best consumer tools to highlight these features is the New Car Assessment Program, or NCAP – which includes the 5-star rating system that appears on all new vehicle window stickers.

Unfortunately, NCAP is currently outdated and not structured to accommodate active safety vehicle options. That is why Delphi supports amending the NCAP to require the 5-star ratings system include active safety technology. These are mature technologies that have been on the road since 1999 and are ready to deploy in high volume, resulting in greater consumer awareness and choice, and a reduction in accidents and fatalities. While these technologies are currently in use, they are in relatively few vehicles. At the current rate of acceptance, it is estimated that active safety technologies will not significantly impact crash statistics for more than a decade.

Incorporating active safety into the NCAP 5-star rating system would help save lives on the nation's roadways. Focusing on Collision Imminent Braking (CIB) and Lane Departure Warning (LDW), at least for initial ratings, will help drive consumer awareness and choice as well as enable technology for future autonomous vehicles.

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

Delphi participation with DOT research

Delphi participates in the Department of Transportation Intelligent Transportation System (ITS) program. Delphi is part of the Crash Avoidance Metrics Partnership (CAMP) along with GM, Ford, Mercedes-Benz, VW, Toyota, Nissan, Honda, Hyundai-Kia, and Continental. CAMP is a public-private consortium which conducts pre-competitive research on intelligent transportation technologies in vehicles. In May 2013, the Federal Highway Administration (FHWA) entered into a 5-year, $45 million cooperative agreement for "projects designed to enable the successful deployment of vehicle-to-infrastructure (V2I) crash avoidance and driver information applications in passenger vehicles."

The ITS program plays an important role in enhancing the government's ability to ground-truth new technologies and lay the foundation for their roll-out. ITS has focused its efforts recently on V2V and V2I roll-out -- both important objectives. ITS should place equal importance, however, on needed analysis and research on active safety such as collision avoidance and mitigation

technologies that are key building blocks for autonomous vehicles. Both V2V enabled and non-V2V enabled collision avoidance and mitigation technologies will be critical to the success of the driverless car. On-board active safety also has the added benefit of saving lives even before V2V communications technologies reach critical mass in the US fleet. Furthermore, non-V2V systems continue to operate in situations where the vehicle encounters communications interference. On-board active safety should be a priority for the ITS program.

Thank you again for this opportunity to testify before your subcommittee today. Delphi looks forward to playing an important role in the road to autonomous vehicles. As we look to a driverless future, we should work to democratize the availability of today's proven technology. Broad scale adoption of active safety will not only lay the foundation for the driverless cars of the future but will save lives now. Delphi stands ready to assist this Committee as you forge the road ahead in advanced transportation technology, and I'll be happy to answer your questions.

Jeffrey J. Owens

Chief Technology Officer &
Executive Vice President

Jeffrey J. Owens is chief technology officer and executive vice president of Delphi Automotive, a $17B global automotive systems supplier. Owens is responsible for the enterprise information technology function and Delphi's global engineering organization, which includes more than 19,000 technologists located in 15 major technical centers. Owens leads the company's innovation strategies while driving advanced technologies supporting the global megatrends of safe, green and connected.

Owens has served in a variety of engineering, manufacturing, finance and product line assignments. He served as president of Delphi Asia Pacific from 2006 to 2009. In his most recent assignment, Owens served as president of Delphi's Electronics & Safety division, establishing key growth product lines including active safety, power electronics for EV/HEVs and consumer connectivity electronics.

Owens earned a bachelor's degree in engineering from Kettering University and a master's degree in business from Ball State University. He currently serves as chairman of the Kettering University Board of Trustees.

Chairwoman COMSTOCK. Thank you. I now recognize myself for questions for—five minute question rounds, we'll have. Let's see. Okay. I wanted to follow up with Mr. Owens on how—with the bill you just mentioned, would that be expected to also bring the costs of insurance down for people who—that are using the technology, and do you have estimates on that?

Mr. OWENS. Yeah, I don't have estimates. I can say anecdotally insurance rates are starting to recognize, and you have to have enough data to get into the actuarial tables. Europe leads the United States here by implementing the five star a few years ago, so in Europe, with a Volvo, for example, you buy your insurance policy when you buy your car, three year policy typically. You get one year free in Europe if you have the active safety portfolio on the Volvo, so——

Chairwoman COMSTOCK. Wow.

Mr. OWENS. —starting to have a benefit, but they'll have to accumulate the data to know exactly what that's going to be.

Chairwoman COMSTOCK. Right. So you'd have saving lives, and then saving money, potentially, so——

Mr. OWENS. Exactly.

Chairwoman COMSTOCK. —a nice combination there. Great. All right. Now—like, with that case, part of getting more dollars for research and development is for us to actually see real life results. So, Secretary Winfree, I wanted to ask about state and local transportation agencies, your—deploy new technologies, such as systems that provide travelers with traffic information, decreasing congestion, you know, where they're telling you what's ahead, and really, you know, transferring more of the information, as well as, you know, we have our cell phones now, when we use them appropriately, that will tell us where the transportation bottlenecks are. How—to what extent is DOT communicating the results of your research on these new technologies to the states and localities so they can then implement it, and then what kind of tracking do you do of that implementation?

Mr. WINFREE. I would say it's principally through two different mechanisms. One is the DOT research hub, and that's a web based portal where all research conducted at the Department is posted and made available to the public. That's certainly the most direct means for that kind of information to be disseminated.

But I would also say, you know, we are hugely supportive of open government, and of the—making access to research results available to the public. We've received a memo from the White House Office of Science and Technology Policy for making research results available to the public. So, by providing access through those two portals, state and local DOTs have access to the research data of federal investment. Can we track it? I would say our best tracking mechanism is following the hits and the results that we get on the research hub, but there isn't a formal means of dialogue with state and local DOTs on those issues.

Chairwoman COMSTOCK. Okay. Do they—did—are they given, like, best practices information, or seminars, you know, efforts to transfer that information at various levels? And maybe if the other witnesses have, you know, I see you're nodding, so if there's some-

thing where you can—if the others would like to jump in to address a little—some ideas on that.

Dr. MEYER. Well, there's—I think there's been a long history of interaction between the USDOT and Federal Highway in particular, on the highway side, with AAHTO, the American Association——

Chairwoman COMSTOCK. Um-hum.

Dr. MEYER. —of Highway Transportation Officials, as well as to the Transportation Research Board. There are, I think, a lot of examples of where there are research briefs, there's discussions, there's conferences, there's workshops. I think there's a pretty good dissemination of research results. The issue, of course, is that there's so much research going on, as I say in my written testimony, there's so many groups doing research that sometimes things happen that you're not quite aware that have a real impact, like your phone, for example, as you mentioned.

So—but my sense is that there is a pretty good relationship going on between disseminating the research results out, whether it be through universities, or through professional organizations, or through groups like the AATHO.

Dr. SMITH. Just to briefly add to that, and one of the—I think the strengths of the UTC program is that the universities can serve as that kind of conduit, to take the research that's been sponsored at the federal level. We know the people in our state and local agencies. We talk to them just informally. We have courses specifically to try to take the results from research and make it more tangible and usable. So we don't just say, here's a paper, read it. We really try to find ways to make it real so that they can implement it, and that's an important part of the UTC program.

Chairwoman COMSTOCK. Great, thank you. And I see my time is just about up, so I—I'll recognize Ranking Member Mr. Lipinski.

Mr. LIPINSKI. Thank you. So many questions here, let me just quickly jump into it. First, for Mr. Winfree—Secretary Winfree and Dr. Meyer, a substantial share of transportation research is conducted, as I mentioned in the opening statement, by federal agencies such as NASA, NSF, DOE, and DOD. For example, Argon National Lab, which is in my district, conducts transportation systems resilience modeling using their supercomputers. But how does the USDOT coordinate with these agencies to make use of resources like supercomputers, and what can be done to develop substantive interactions with other federal agencies?

Mr. WINFREE. Thank you for the question, Mr. Lipinski. DOT works across the enterprise, from a federal agency perspective. We work with many different agencies and departments, depending on the issue at hand. So, for example, workforce development, which is a key role that we play at the Department, we partnered with the Department of Labor, the Department of Education, to have a continuum. With respect to renewable energy and sustainable transportation, we work very closely with the Department of Energy. Just yesterday I spoke with the NASA Jet Propulsion Laboratory about combining our knowledge to research automation, and—looking forward to, you know, unmanned aerial devices, and other kinds of technologies. JPL is one of our key partners there, or will be as well.

So the best way to put it is we're aware of what's going on across government. We work collaboratively with those agencies and departments in many different spaces. We partner with the Department of Defense in maintaining the GPS satellite Constellation. So all of these different technologies are resident—that are resident at DOT we're aware of across government, and work collaboratively with other organizations.

Mr. LIPINSKI. Thank you. Dr. Meyer?

Dr. MEYER. Thank you, Congressman. I—yeah, my sense on this is that much of the research that's done at national laboratories, for example, in the transportation area is often done under contract with the DOT, so the DOT is pretty much aware of it.

What doesn't happen, in my opinion, is that there's a lot of work that's been at Argon, and Los Alamos, and others that have relationships to transportation, but weren't—they didn't originate from the transportation community, so to speak, or from the DOT. And we kind of find out about them, after the fact type of stuff. And that goes back to my testimony about having this new framework, this research framework that kind of lays out what it is that we, as a nation, really need to be focusing on with regard to key ideas, key thoughts, key research concepts, and then making—then seeing what everyone—what part everyone has to play.

I mean, I've seen work that's been done by EPA, for example, that folks at DOT didn't—weren't even aware of, but—strictly related to the transportation group. So I have no doubt that there is coordination and there's discussion going on, but given a government the size of our government, things do happen out there from different sources that I think could be better coordinated, quite frankly.

Mr. LIPINSKI. Thank you. Next question, and I'd like to go into this more, but a simple yes or no, just with limited time. I'm hoping for a particular answer. I think I'll get it. The National Freight Cooperative Research Program was eliminated in MAP 21, so I want to ask Secretary Winfree and Dr. Meyer, would reinstalling this program help inform national freight strategy?

Mr. WINFREE. Yes, and we've requested that in Grow America.

Dr. MEYER. And I cannot agree more with that, because——

Mr. LIPINSKI. Microphone?

Dr. MEYER. I'm sorry. I thought mine was on. I can't agree more with that. My—it's a big yes. I was shocked that, in fact, it was de-authorized, or whatever the term was. I think it's a very valuable program that should be reinstituted.

Mr. LIPINSKI. All right, thank you. And last, for Mr. Owens and Secretary Winfree, Mr. Owens, Delphi is at the forefront of demonstrating the technology that's available. V2V will be rolling out next year with GM and others, and self-driving cars are testing out extremely well. So far these two initiatives are running almost independently. I want to ask, do you believe that autonomous driving can be made safer by using V2X technology, and what should be done to bring the two streams of research together?

And let me throw in this one other part, if anyone wants to give an answer. One of the most fascinating things to me was a—when I had this panel out in the Bay Area, Silicon Valley, is how much more efficient can our system get with technology, the current road

system we have right now? So, Mr. Owens, I don't have much time, so——

Mr. OWENS. Yeah.

Mr. LIPINSKI. —whatever you can add to it——

Mr. OWENS. So, first of all, I don't consider that those are two separate initiatives. If you look at our vehicle that we put on the road, it had all of the technologies, including V2V and V2X, on there. We'll be first to market next year, with General Motors, to V2V.

It's a matter of building blocks. It—to get to a fully automated vehicle, or even semi levels of automation, it's—you take the technology that's available and ready today. Active safety is ready today. Vehicle to vehicle technology is not—there's nothing more to invent there. It's a matter of implementation, but it's not on the road today. As it goes on the road, you've got a radar system, you've got a vision system, you get a very compelling scenario analysis in front of the vehicle to help the vehicle decide what actions to take, where the threats are. You add to that, then, when it's ready—vehicle to vehicle, it's a wonderful addition to those building blocks to help complete that scenario of what's around the vehicle, even more so through the intersection on further down the road. So I—very complimentary. Again, on the roadmap to a fully automated vehicle, I consider all those technologies critical.

Mr. LIPINSKI. Well, let me—because I'm over time already, you go—it says, Secretary Winfree, adding to that—does anyone want to give an estimate of how much more efficient—because I have heard between two times and four times more efficient, that if we could put that many more vehicles on our current road system if we have completely autonomous vehicles with all the technology, you know, gets—V2X is out there, how much more efficient can we get?

Mr. OWENS. Well, I can—

Mr. LIPINSKI. I'm not going to hold you to this.

Mr. OWENS. Yeah. I can give you the data that I've read, as others have. A report just came out from one of the consulting groups two weeks ago that said you'll require 40 percent less vehicles. You'll require 80 percent less parking. I mean, those kinds of statistics. So I can't validate the numbers, but that's—I mean, generally that would be in the ballpark of what you could expect.

I can tell you, closer in, before you get to automated, if you put even adaptive cruise control, being able to automatically set the headway, just that, three to five percent pickup in fuel economy if you just have one out of four cars that have it on the highway. If you get two cars out of four that have it on the highway, you're in the five to eight percent pickup because you have smoother flow, you have less gridlock, you less of the accordion effect when traffic stacks up. So I think those statistics are pretty compelling, even in the near term, before you get autonomous.

Mr. LIPINSKI. Well, I'll yield back. Now, I'd love to hear more, but I'm going way over. Thank you, Chairwoman.

Chairwoman COMSTOCK. Thank you, and Mr. Moolenaar, you're now recognized.

Mr. MOOLENAAR. Thank you, Madam Chair, and I want to thank all of you for sharing your insights with the Committee. And I've learned a lot already today, so appreciate that.

Secretary Winfree, I wanted you, if you could, to elaborate a little bit. You mentioned in your testimony some of the work being done in Ann Arbor. And, as a Michigan representative, you know, I'm aware of some of the work they're doing. They've created a mobility transformation facility, and—to test how autonomous vehicles respond to real world situations. And what I was hoping you might do is just elaborate on how you work with them in this regard. And I know there are some plans to expand also through the Detroit corridor.

Mr. WINFREE. Yes, thank you for the question. And the first thing I would point out is that I'm extraordinarily pleased to be here with UTC representatives. As they've both mentioned, the UTC program is extraordinarily strong in supporting our transportation initiatives. So, to carry that further, we're working with the University of Michigan, another one of our UTCs, on connected vehicle technologies, and they are putting together the Southeast Michigan Connected Corridor. So, from Novi past Detroit, that will be a roadway test bed, kind of a living laboratory, that looks at connected vehicles, vehicle to vehicle communications, vehicle to infrastructure, everything from road weather to signal phase and timing.

So it'll be a—again, a living platform that the University of Michigan, in the conduct of our connected vehicle safety pilot, first developed. So the safety pilot was a 3,000 vehicle circulating in and around Ann Arbor, giving us that rich data that was used to inform the NHTSA AMPRM. So we're very supportive on the research side of where NHTSA wants to go with connected vehicle technology. And all this is made possible by our strong partnership with the University of Michigan.

Mr. MOOLENAAR. Wonderful. Thank you. And I also wondered if you might comment on some of the policy issues for autonomous vehicles, and how the research at the universities has contributed towards, you know, clarifying some of the policy issues. And then one in particular I was hoping you might talk about is—I've heard from individuals about spectrum availability for vehicle to vehicle technology, and that the—on May 13 Secretary Fox announced plans to accelerate the rulemaking proceeding. And I don't know all the specifics of that, but I guess the core question I have is, is that going to require an additional funding request, or do you feel that funds are sufficient to accelerate that process?

Mr. WINFREE. With respect to the first question, the question about spectrum business is quite lengthy, so maybe I'll start there first, because it's an important question for me to address. V2V operates in the 5.9 Gigahertz spectrum. Right now the Wi-Fi industry is interested in sharing that spectrum for UNII devices, Unlicensed National Information Infrastructure, devices. The problem is we can't tolerate interference in critical safety of life applications.

DSRC communicates 10 times per second relative speed, steering wheel position, brake force, et cetera, of what a vehicle that's potentially in a collision scenario is doing. So it gives drivers advance warning to engage in evasive or preventive maneuvers and avoid

crashes. As we know, we have 32,719 fatalities on our roadways, and that number is unacceptably high, as Mr. Owens has pointed out. So this is a critical technology that will really reduce and address those crash scenarios. We're not averse to testing, but, again, we need devices, and the Wi-Fi industry has not produced 5.9 Gigahertz Wi-Fi devices for us to test in a real world scenario. We have a current testing platform in—data—test bed in Cheltenham, Maryland, at the DHS federal Law Enforcement Training Facility, where we'll be able to engage in testing as soon as devices are delivered.

So that's what Secretary Fox said when he said that, look, we're going to move forward with our rulemaking with respect to V2V. We are willing to work with industry on testing to see whether or not there is harmful interference. We think that within 12 months we'll have data that will let us know up or down whether or not testing—sharing can be tolerated. But none of that can start until we get devices, so we're moving on dual tracks with—full speed ahead for the NHTSA NPRM, but we're also interested in working with industry, should they provide the devices that we need.

Mr. MOOLENAAR. Thank you very much. Thank you, Madam Chair.

Chairwoman COMSTOCK. Thank you, and I now recognize Mr. Westerman.

Mr. WESTERMAN. Thank you, Madam Chair, and I do appreciate you all coming and testifying today. This is the kind of stuff engineers like to listen to.

So my first question is to Secretary Winfree regarding research and development technology. How does the Office of the Assistant Secretary for Research and Technology identify duplicative research programs at the Department of Transportation, and if redundancies are identified, how are they addressed?

Mr. WINFREE. Thank you for the question. The reason this organization was stood up, and you may remember the original RITA, the Research and Innovative Technology Administration, my office is that office, but we're now elevated into the Office of the Secretary.

Our principle role is research coordination across the Department, and the means in which we effect that are through monthly RD&T planning team meetings. So we bring together the associate administrators of research across the Department's operating administrations, and on a monthly basis engage them in a discourse and dialogue about what each research organization is working on.

And just by, you know, getting us out of those stovepipes, and having those discussions, has really brought to light a lot of the activities that are going on. It's helped us reduce—or, you know, address whether or not there are duplicative, you know, research programs. As custodians of taxpayer dollars, we're extraordinarily sensitive to the need to—and the responsibility to be as fiscally responsible as possible. So that's the principle means for us to do that.

We also have an RD&T planning council executive committee, and those are where the administrators across the Department are brought together as well to talk about what their individual organizations are doing. So just by staying closely engaged with the re-

search community across the Department is the best way for us to tackle that issue.

Mr. WESTERMAN. All right. Next question, for Dr. Smith and Dr. Meyer, you know, with the issues with funding for transportation, when conducting research for transportation systems, how much emphasis is placed on life cycle cost, initial construction cost, and overall economic impact of designs as it relates to earthwork, and base preparation, and pavement systems, and, you know, things like bridge and overpass structures?

Dr. MEYER. That is a great engineering question. Thank you for that. As a fellow engineer, I take it. Several years ago, I don't know when the specific date was, the DOT actually issued a policy saying that, you really need to do life cycle costing in terms of federal projects, for example. And so the research part of it is very much looking at—when you look at new materials, composite materials, nanotechnology, all that type of stuff, we are looking at, from a research perspective, over the life—total life cycle, in terms of the replacement, the recycling, and the O and M during the life of it, as well as the initial capital, and the recapitalization as you go through.

So I would say that most research that deals with the structure side, the materials side, the equipment/technology side is very much focusing on the issue of life cycle costing. That's just the way that we look at benefit/cost now these days.

Mr. WESTERMAN. So can you give some examples of recent developments in highway transportation that have resulted from federally funded research that have increased transportation durability and——

Dr. MEYER. I——

Mr. WESTERMAN. —reduced life cycle cost?

Dr. MEYER. Sure. I think the obvious example is the pavement research that was done to so-called super pave, I guess is the phrase for it, where we went to Europe and other places to see how they did certain things, came back, and kind of recomposed how we did our pavement surfaces, and developed pavement materials, and pavement construction technologies, that made the life of the pavement much longer.

And so—then that was funded through the—I think it was through DOT, through the Sharp Program, or the through the Transportation Research Board, but the money came, to a large extent, from the Department of Transportation. So I think that's a clear example, in terms of how research has really led to longer lived, longer life, if you will, with regard to materials that every state DOT in the country uses.

Mr. WESTERMAN. So is the real apple out there still in materials? You mentioned nanotechnology. What can we expect in the future? Because, you know, you think about how long highway systems have been analyzed in research.

Dr. MEYER. Yeah.

Mr. WESTERMAN. What's left to gain?

Dr. MEYER. Well—and I, you know, as a former researcher, there's always a lot of apples, you know, that you want to eat and bite into. I certainly believe that materials is an area where there's

a lot yet to gain, in terms of higher strength, lower weight type of materials, the so-called composites and nanotechnology.

I—in—what we've been talking about before is the operations of the system, the V2V, V2I type of stuff, which I do think there's tremendous efficiencies and tremendous additional effectiveness that we can get out of our transportation systems by looking at how to better manage through technology. So I—that's another area where I think we can really gain a lot, in terms of research and technology development. But materials certainly is one where I think we can—we need to continue our research and technology to get those efficiencies out of the materials.

Mr. WESTERMAN. I'm out of time, Madam Chair.

Chairwoman COMSTOCK. I now recognize Mr. Palmer.

Mr. PALMER. Thank you, Madam Chairman. A couple of questions. Mr. Winfree, for fiscal year 2016 budget requests for the National Highway Traffic Safety Administration, Vehicle Research and Analysis Programs was 39.7 million, to be used to conduct motor vehicle safety research and develop advanced vehicle safety technology. Does this research duplicate research being done by the automakers and other private entities?

Mr. WINFREE. I would say it's complimentary. You know, those are vexing issues, and they're looking at it from different perspectives. Certainly the OEMs have a vested interest in those technologies for protecting passengers, as well as, you know, their ultimate customers down the line, but NHTSA looks at it from a safety perspective. We are a safety first organization, and those technologies, we believe, are the best means for kind of a holistic view about occupant safety.

One of the things we talk about at DOT is the first 50 years have been focused on having vehicle occupants survive crashes. The next 50 will be about avoiding crashes altogether. So all of that is part of a continuum of research at NHTSA.

Mr. PALMER. Well, I was going to ask something else, but because you put so much emphasis on vehicle safety, as opposed to infrastructure, there's a role in that. And I do think there's a role, and I'll come to Dr. Meyer on this in a moment.

The President is proposing the corporate auto fuel economy standards to be 35.5 miles per gallon for—by 2016, and 54.5 by 2025, yet the research shows that—and I think the National Highway Safety Standards Board made this projection that for every 100 pounds you reduce the weight of a vehicle, that it increases the highway fatalities by just about five percent. And there's research and data out there that indicates that thousands of people have died as a result of being in lighter vehicles that were basically forced upon the automobile industry. How do you respond to that, and what does the highway—well, what does your group—what are you doing in the context of trying to improve vehicle safety from that perspective, when you're—seem to be working—the ends that you're trying to get to seem to be at odds with each other.

Mr. WINFREE. No, thank you for that, and, unfortunately, I'm not as expert as I should be in responding to that question, so I have to defer, perhaps to questions for the record. But one thing I would say, you know, if you look at the light-weighting of vehicles in auto racing, you know, concept, they're able to construct vehicles that

are withstanding crashes of significantly more velocity than on our roadways today. So there are technologies available, there are materials available, that will make for lightweight, but strong, vehicles that will protect occupants.

Mr. PALMER. I appreciate that, but there's basic physics involved here, and, you know, while you're trying to work toward a solution toward this, there's still people going to die because of these government imposed standards.

Mr. Meyer, you talked a little bit about the composite materials, and things that you're using on—for highway services. What kind of research is out there on that end that will not only make it less expensive to—for highway construction, but safer in the context of vehicle transportation?

Dr. MEYER. Well, I'm not that familiar with vehicle composite—which is what Mr. Winfree was talking about, in terms of the vehicles themselves, but on the infrastructure side there's been a large amount of research on structures, bridges, for example, being designed and built out of composite material so that, in fact, they're much, much long—have longer lives, and they don't have to be maintained as much.

With regard to the safety element to it, I wouldn't say it so much on the composite materials side as it is the types of materials that you put into roads, intersections, and the interface with the vehicle and tires that, in fact, make the actual movement of the vehicle along that pavement much safer, in terms of what's wet pavement, and that type of stuff. So there's a lot of work that's been done on that. I wouldn't, again, call it a—composite materials, but it's a different type of materials research.

Safety is a huge focus for a lot of universities, as well as government agencies on the materials side, as well as on the operations side, and, as you mentioned, also on the vehicle side. So I think that one can certainly point to a fair amount of research that I'm aware of, at least at—on the materials side, that relates directly to safety—safe movement of vehicles and trucks.

Mr. PALMER. Let me just conclude my time by going back to the original question, about the duplication of research. And I think, in our current budget situation, we want to eliminate as much duplication as we can, and there is excellent research being done at Auburn University, at the National Center for Asphalt Technology. So if—in the event that you're not familiar with that, I encourage you to talk with them about surface transportation and highway safety. Thank you, Madam Chairwoman.

Chairwoman COMSTOCK. Thank you. And I just want to thank our witnesses today for your testimony, and for, really, the exciting innovations that you all are working on, and I'd like to invite you to, you know, continue to share any information or developments as you see, and to inform the Committee. And we very much appreciate you being here this morning, and thank you for the early start too. We have, as you may know, some busy votes ahead of us today. So thank you very much.

The record will remain open for two weeks for additional comments and written questions from members. And, again, we really appreciate your valuable testimony, insight, and the spirit of inno-

vation reflected here this morning. Thanks so much. And the hearing is adjourned.

[Whereupon, at 10:22 a.m., the Subcommittee was adjourned.]

Appendix I

Answers to Post-Hearing Questions

ANSWERS TO POST-HEARING QUESTIONS

Responses by The Hon. Gregory D. Winfree

HOUSE COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY
SUBCOMMITTEE ON RESEARCH AND TECHNOLOGY

"U.S. Surface Transportation: Technology Driving the Future"

Questions for the record, Mr. Gregory Winfree, Assistant Secretary for Research and Technology, United States Department of Transportation

Questions submitted by Rep. Barbara Comstock, Chairwoman, Research and Technology Subcommittee

1. How has the administrative change of placing the Research and Innovative Technology Administration into the Office of the Secretary for Research and Technology supported cooperation and coordination in DOT's research activities? Has this move resulted in an elevated status for research programs, and if so, how? Have there been unforeseen consequences, either positive or negative?

Response: *The Research and Innovative Technology Administration's (RITA) elevation into the Office of the Secretary as the Assistant Secretary for Research and Technology (OST-R) has heightened a Departmental emphasis on and awareness of the critical role of research and data in addressing the Nation's transportation challenges. OST-R has been called upon more routinely to provide research results and other input to DOT policy processes and decisions. For example, OST-R has played a leadership role in the development and validation of Secretary Foxx's 30 Year Framework for the Future, Beyond Traffic 2045: Trends and Choices.*[1]

OST-R already closely partners with universities on innovations with real-world applicability on behalf of the Department and of specific modes. One new initiative is to conduct an annual technology scan looking out three-to-five years relative to multi-modal transportation issues and challenges (e.g., impaired operator detection technology, cyber security, software safety assessment, etc.). Communication of that scan to our partners, and discussion about it, will foster attention to Department-wide research needs.

But we have more to do. We would like to grow the Departmental culture of innovation through closer collaboration with the Defense Advanced Research Projects Agency, Advanced Research Projects Agency-Energy, the National Laboratories, National Aeronautics and Space Administration, and other Federal innovation centers. For areas that are cross-departmental in nature, such as reducing greenhouse gas production in the transportation sector, and understanding the impact of vehicle sharing on land use, closer collaboration on research with the Department of Energy and the Department of Housing and Urban Development will help us to address the research needs.

Not unsurprisingly, in the first year of the elevation to the Secretary's office, considerable personnel resources were required for administrative re-organization, including budgetary realignments. With that now firmly in place, OST-R is working to strengthen the coordination and collaboration of research within the Department, with other governmental entities, and with

[1] *See* Beyond Traffic: US DOT's 30 Year Framework for the Future, http://www.transportation.gov/BeyondTraffic.

private and university partners. A key component of that effort is the use of the DOT Research Hub as the repository of all ongoing Departmental research projects, and of the National Transportation Library as the repository for all research results. With an easily searchable database that includes completed and ongoing research, opportunities for collaboration can be more easily identified.

There will still be "growing pains", but OST-R will continue to foster collaboration through a number of mechanisms that have more persuasive power from within the Office of the Secretary.

2. What are DOT's top RD&T priorities?

Response: *The Department's top research priorities are identified in the most recent U.S. Department of Transportation Research, Development, and Technology (RD&T) Strategic Plan, Fiscal Year 2013–2018.*[2] *Guided by the Department's Strategic Priorities and priorities defined by Congress in legislation, the Plan identifies five RD&T priority areas for the Department:*

1. *Promoting Safety*
2. *State of Good Repair – Preserving the Existing and Extending the Life of Future Transportation Systems*
3. *Economic Competitiveness and Improving Goods Movements*
4. *Livable Communities – Reducing Congestion and Improving Mobility*
5. *Environmental Sustainability – Preserving the Environment*

Safety continues to be the Department's number one priority. The Department RD&T multimodal safety research priority areas, supported by coordinated research programs across all Departmental organizations, include:

- *Advance research into the causal role of human factors in safety issues, specifically impairment issues such as alertness, operator capability and readiness, and fatigue;*
- *Advance vehicle system design to avoid collisions through advanced technologies, and mitigate safety consequences of unavoidable collisions;*
- *Design a transportation system that will improve safety and efficiency, focusing on safety risk, detection, and warning system reliability;*
- *Standardize transportation safety data collection and terminology;*
- *Develop a multimodal Department safety incident and close call data collection system to help evaluate and analyze transportation safety performance and address transportation safety issues;*
- *Plan freight and hazardous material cargo routing to improve safety and reduce environmental risks; and*
- *Ensure radio frequency spectrum continues to support critical safety of life applications.*

All other priority RD&T areas have also defined multimodal goals supported by some portion of the Department's research portfolio. These goals were approved, and are routinely reviewed by, the Department RD&T Planning Council. The Council is chaired by Assistant Secretary for Research and Technology and includes all heads of Operating Administrations and relevant

[2] *Available at* http://www.rita.dot.gov/rdt/sites/rita.dot.gov.rdt/files/rdt_strategic_plan_2013.pdf.

Secretarial offices.

3. Dr. Meyer's testimony described recommendations from the Transportation Research Board's Special Report 313 to help the U.S. transportation research enterprise. These include the creation of a "chief scientist" within DOT and an Office of Science and Technology Policy panel to coordinate research conducted at other agencies related to transportation. Would implementation of these recommendations positively impact research coordination among the various DOT administrations?

Response: *The Department believes that the recommendation in Transportation Research Board (TRB) Special Report (SR) 313 that there be a chief scientist was accomplished by the creation of the Office of the Assistant Secretary for Research and Technology, as that office is charged with many of the chief scientist duties envisioned by SR 313. The Assistant Secretary for Research and Technology is designated the "principal advisor to the Secretary and representative of the Department with respect to scientific and technological matters."*

4. What is the status of developing and deploying autonomous vehicle technologies nationwide, and how long do you estimate until we have significant numbers of driverless vehicles on the road?

Response: *The Department is aggressively pursuing safe and secure automated vehicle technologies that cut across all levels of automation, given the impact that these technologies can have in saving lives. The GROW AMERICA Act dedicates an additional $222 million over six years to accelerating autonomous vehicle research and development, including necessary research on system data privacy and security. In addition, Vehicle-to-Vehicle (V2V) and Vehicle-to-Infrastructure (V2I) technology will make these automated technologies even better, and together, the combined technologies will serve as the fundamental building blocks for full self-driving vehicles. While it will take a number of years for these technologies to become ubiquitous in the fleet, the Department is looking for opportunities to accelerate that deployment.*

5. New electronic technologies are increasingly being incorporated into vehicles for safety, mobility, and environmental reasons, as well as to enhance the consumer driving experience. However, the increasing use of such technologies, along with the development of "connected" vehicle technologies raises privacy concerns in terms of how this information is stored, used, and accessed.

    a. What kinds of information would be collected and stored in autonomous and connected vehicles, and who might have access to such information?

Response: *Autonomous (or self-driving) vehicles are still in research and development phases, and development-stage data collection and storage practices are likely not reflective of deployment-stage systems.*

The V2V system that the Department has been developing, along with several research partners, is designed with privacy in mind. No personal vehicle identification will be collected, broadcasted, or shared. The Department is committed to supporting deployment of V2V technologies in a manner that protects consumers from unwarranted privacy risks and safeguards the system from unauthorized access.

In addition, vehicle manufacturers recently released a set of privacy principles covering the infotainment and safety systems they plan to implement, including principles on disclosure to consumers about data collection and its use.

b. What cybersecurity measures will need to be put into place to safeguard security and privacy for connected and automated vehicles, and what provisions are currently in place for research in the area of vehicle cybersecurity?

Response: *The Department has developed a research program that takes a layered approach to cybersecurity for automobiles. Within the resources provided, the Department is executing that program to inform NHTSA's decisions on next steps. This approach assumes all entry points into the vehicle, such as wireless communications, infotainment, the On-Board Diagnostics (OBD-II) port, and other points of potential access to vehicle electronics could potentially be vulnerable, and is focused on hardening the vehicle against attacks and ensuring vehicle systems take appropriate steps when an attack occurs. The V2V system that the Department has been developing, along with several research partners including cryptographic experts, would use a Public Key Infrastructure (PKI)-based system to ensure trusted and secure communications between V2V and Vehicle-to-Infrastructure devices.*

6. As we move toward a world where autonomous vehicles are the norm, how would you define the "operator" of the vehicle, and who would you hold liable in accidents? What other legal issues need to be considered relative to autonomous vehicle technologies?

Response: *There are different levels of automation, and not all vehicles with some automated technology can be considered "fully automated". NHTSA expects that automation will develop in stages, with many vehicles designed so that both the vehicle and the driver may have driving responsibilities depending on the situation. In cases where drivers have driving responsibility, NHTSA would expect them to be the operator. Liability in automobile crashes is a matter of State tort law, not Federal law. There are a variety of legal issues associated with automated vehicle technologies, some of which NHTSA discusses in its Preliminary Statement of Policy Concerning Automated Vehicles, and some of which are discussed in the article entitled "Potential Regulatory Challenges of Increasingly Autonomous Vehicles."*[3]

7. One of the features of Google Doc is the ability to save and regenerate every edit made to a document by a user. A similar feature in vehicles would likely be extremely valuable for people or companies that want to access the complete travel history of an autonomous car and its passengers. Does such technology exist, or is it in the works? If so, how would the relevant privacy boundaries be established?

Response: *The Department is not aware of a similar feature being developed for vehicles sold to consumers. If the vehicle manufacturers develop and utilize a similar feature in vehicles, presumably any privacy-salient personal information it collects and/or shares would be subject to the disclosure provisions contained in the privacy principles promulgated by the manufacturers (which would be enforced by the Federal Trade Commission, not by the Department).*

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[3] S. Wood et al., *The Potential Regulatory Challenges of Increasingly Autonomous Motor Vehicles*, 52 SANTA CLARA L. REV. 1423 (2012), *available at* http://digitalcommons.law.scu.edu/lawreview/vol52/iss4/9/.

8. Positive Train Control (PTC) implementation is consuming billions of dollars and is not expected to be implemented by the December 2015 statutory deadline, raising the question: is PTC the right technology? Also, some have suggested that the technology we take for granted now in our smart phones, which wasn't developed at the time of PTC's origination, could be adapted to be just as effective and much less expensive than PTC. Has the Department considered alternatives to PTC?

Response: *Positive Train Control (PTC) technology is arguably the single-most important railroad safety development in more than a century. The technology is not new—early versions of PTC technology existed in the early 20th century—and regulators and safety advocates have been calling on railroads to implement some form of PTC technology for many decades. A safe rail system requires full PTC implementation. Congress required the installation of PTC, despite the cost-benefit ratio.*

Railroads are making use of cellular technology, such as that used in smartphones, where practical to provide a communications path between the other PTC subsystems. Smartphone technology, however, lacks key elements necessary to act as a replacement for the other elements of the PTC system. First, they only work where there is cellular service. Second, since there has been no set aside of cellular frequencies for railroad use, railroads would be forced to compete for sufficient dedicated cellular bandwidth. The railroads would be directly competing with the telecommunications companies for this limited resource. Third, the location determination system in the smartphone is sufficiently inaccurate as to preclude its use as the sole means of position determination. As a consequence, alternative location determination systems would be required. Fourth, the phone would still require integration into the locomotive control systems in order to affect control of the locomotive when the engineer fails to take control. Fifth, the software in smartphones has not been developed to the same safety-critical standards and methodology as a PTC system.

The Federal Railroad Administration (FRA) has considered the use of new and existing alternative technologies where appropriate, and has asked for congressional authority to allow such installation in lieu of PTC on lower-risk lines.

9. Research studies have shown that working night hours (typically midnight to 6 a.m.) substantially increases the risk of both fatigue and human factor errors compared to working daytime or other hours. What R&D work has DOT conducted regarding working nighttime hours compared with daytime hours and what have been the results? What types of mitigation measures should be developed to address the risk of fatigue associated with working nighttime hours?

Response: *As shown on the DOT Research Hub website[4], there is a total of 32 active projects funded by seven Operating Administrations, amounting to approximately $18M in research funding. The Federal Motor Carrier Safety Administration (FMCSA) is particularly active in this area, investing over $11M in fourteen projects through an extensive driver fatigue research program focused on commercial drivers.*

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[4] *See* USDOT Research Hub, *available at* http://ntlsearch.bts.gov/researchhub/index.do (a public-facing website cataloging Department-funded research).

Across the Department, a number of mitigation measures are currently in use. Regulators, employers, and unions have used fatigue model outputs to manage the risk of fatigue-related errors and accidents. More specifically, the Federal Aviation Administration (FAA) and Federal Railroad Administration (FRA) have used fatigue models to support Hours of Service (HOS) rulemaking, and investigative agencies, such as the NTSB, have used them to better determine whether fatigue is a contributing factor in a crash. Additionally, the Code of Federal Regulations for rail includes requirements for commuter and intercity passenger carriers to supply FRA with fatigue mitigation plans and analyses of work schedules using an FRA-approved and validated biomathematical fatigue model for hours of work with the greatest fatigue risk.

Beyond modeling, numerous interventions exist. As part of the Rail Safety Improvement Act of 2008, Rail Risk Reduction Programs must include a fatigue management plan with requirements for employee education and training.[5] Railroad employees and their families can access an online resource for guidance on adjusting to a shift work lifestyle that will promote healthy sleep and therefore reduce fatigue.[6] Technology can also be used to help with workforce planning in the form of staffing and work schedule analyses. When properly implemented, fatigue risk is minimized through employing the necessary number of staff to support properly the recommended work schedule for an organization. A range of policies, practices, and procedures aimed at minimizing fatigue, such as napping[7] and break policies,[8] have been examined. Real-time, continuous alertness monitoring is an area of great promise, but needs further research.[9]

10. Regarding train or motor carrier safety, if a human being must always be on hand and ready to take over under special circumstances, has the Department conducted any research on how to keep that human being engaged and alert during hours of passivity or inactivity?

Response: *To date, FMCSA's driver fatigue research has focused on traditional vehicles; however, FMCSA is planning to undertake research to examine the potential impacts of automated vehicles on the commercial motor vehicle safety regulations. This may include research on technologies to ensure driver alertness in automated vehicles.*

FRA has conducted research on locomotive engineer fatigue and sustained attention. FRA is equipping its Cab Technology Integration Laboratory (a full-size locomotive cab simulator) with PTC to enable further studies into human interface with the new technology.

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[5] *See* Fatigue Management Plan Regulation Content, *available at* https://www.fra.dot.gov/Elib/Document/1821.
[6] *See* Railroaders' Guide to Healthy Sleep: Steps to Improve Your Sleep and Make a Real Difference in Your Life, www.RailroaderSleep.org.
[7] P. Della Rocco et al., *The Effects of Napping on Night Shift Performance* (DOT/FAA/AM-00/10) (2000), *available at* http://ntl.bts.gov/lib/17000/17600/17667/PB2001102912.pdf.
[8] C. Chen & Y. Xie, Modeling the Safety Impacts of Driving Hours and Rest Breaks on Truck Drivers Considering Time-Dependent Covariates, 51 J. OF SAFETY RES. 57-63 (Dec. 2014), *available at* http://www.sciencedirect.com/science/article/pii/S0022437514000942.
[9] *See, e.g.*, National Highway Traffic Safety Administration's *Assessment of a Drowsy Driver Warning System for Heavy-Vehicle Drivers*, http://www.nhtsa.gov/Driving+Safety/Drowsy+Driving.

11. The use of Unmanned Aerial Systems (UASs) for the purpose of pipeline inspections and mapping seems self-evident. Does the Pipeline and Hazardous Materials Safety Administration (PHMSA) have any work in place that considers the viability of using UAS technology to fulfill its mission, and if not, is there any potential in doing so?

Response: *Yes. In consultation with the Pipeline and Hazardous Materials Safety Administration (PHMSA), the pipeline industry has started limited work on using Unmanned Aerial Systems to: visually inspect suspended pipelines on bridges; monitor pipeline right of ways for encroachment; and detect and locate natural gas leaks. For example, BP, a major U.S. pipeline operator, obtained FAA approval in June 2014 for Unmanned Aerial System operation over land to survey pipelines, roads, and equipment in Prudhoe Bay, Alaska.*

FAA currently authorizes the use of unmanned aircraft systems (UASs) for commercial or business purposes only on a case-by-case basis, greatly limiting their use.[10] *FAA issued a Small UAS Notice of Proposed Rulemaking (NPRM) in February 2015 for routine commercial use of UAS under 55 pounds, for daylight visual-line-of-sight operation, and up to 500 feet altitude, which may increase UAS usage in the future.*[11]

In 2014, PHMSA solicited for leak detection research proposals, which may include UASs, and PHMSA continues to solicit research proposals for leak detection and other technologies, where UASs may be involved.

Under the Office of the Assistant Secretary for Research and Technology's Commercial Remote Sensing & Spatial Information Technologies program, projects have been completed using remote sensing tools for natural gas pipeline monitoring, pipeline damage prevention, and pipeline operator decision support systems.

12. An April news article describes PHMSA as "an agency that lacks the manpower to inspect the nation's 2.6 million miles of oil and gas lines, that grants the industry it regulates significant power to influence the rule-making process, and that has stubbornly failed to take a more aggressive regulatory role, even when ordered by Congress to do so."
    a. What visibility do you have on the research, development and technology programs within PHMSA, and given the quote referenced above, what assurance can you provide the Committee about the agency's competency in those areas?

Response: *PHMSA's R&D program uses a competitive merit review process to assure PHMSA's research awards are best suited to address the selected priorities aligning with PHMSA's pipeline safety mission and goals. After award, PHMSA tracks the programs and provides visibility to the public through PHMSA's R&D website. Since 2002, there have been 25 technology improvements and 22 patents as a result of PHMSA's R&D program. Further, the PHMSA R&D website has over 1 million downloads.*[12]

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[10] *Know Before You Fly*, http://knowbeforeyoufly.org/for-business-users/.
[11] For information on FAA's NPRM on Small UAS, please visit: https://www.faa.gov/uas/nprm/.
[12] PHMSA's R&D Website can be accessed at: https://primis.phmsa.dot.gov/rd/index.htm.

13. The Department of Energy's (DOE) 2015 Quadrennial Energy Review (QER) states that about 50% of the U.S. gas transmission and gathering pipelines were constructed in the 1950s and 1960s. The QER suggests that natural gas interstate pipeline investments could cost $2.6 billion to $3.5 billion per year between 2015 and 2030, and the total cost of replacing cast iron and bare steel pipes in gas distribution systems is estimated to be $270 billion. What can you tell us about PHMSA's priorities in the area of replacing these old gas pipelines and state of technology regarding pipelines? How do the two agencies-DOT and DOE-coordinate work on pipeline RD&T?

Response: *In 2011, the Department issued a Call to Action to engage all state pipeline regulatory agencies, technical and subject matter experts, and pipeline operators in accelerating the repair, rehabilitation, and replacement of the highest-risk pipeline infrastructure throughout the country. PHMSA continues to pursue this goal through a variety of actions. The Call to Action addresses many concerns related to pipeline safety, such as ensuring pipeline operators know the age and condition of their pipelines, proposing new regulations to strengthen reporting and inspection requirements, and making information about pipelines and the safety record of pipeline operators easily accessible to the public. In an effort toward public transparency regarding the challenges of potentially higher risk pipelines, PHMSA created an interactive website through which the public can assess the national and state replacement of cast iron and bare steel pipelines.*[13]

PHMSA continues to foster RD&T to improve the ability to assess pipeline integrity and preempt through remediation any potential safety issues. PHMSA coordinates RD&T with a variety of Federal and state agencies to assure the highest safety priorities are addressed in efficient and cost effective ways. Notable among these partnerships is PHMSA's decade-long relationship with DOE's pipeline research programs. DOE has tended to research advanced pipeline technologies related to alternative fuels and other concerns – for example, their Pipeline and Reservoir CO_2 Project, and more recently the Natural Gas Infrastructure R&D Program to reduce methane emissions. PHMSA safety R&D both works with DOE research on common interest – for example, new materials for pipeline sleeves – and learns from DOE research that may have a direct bearing on safety technologies and practices. On the latter, PHMSA is watching closely DOE's work under the Natural Gas Infrastructure R&D Program's goal of developing a cost-effective means to provide a continual leak detection capability.

14. According to PHMSA, excavation damage is one of the leading causes of pipeline incidents because of a lack of communication among stakeholders, i.e. facility operators, locators and excavators. What has PHMSA done since the implementation of the 811 "Dial Before You Dig" program to encourage utilization of communications technologies to improve excavation safety practices? Does PHMSA have any R&D plans in the works to study whether advancements in GPS digital mapping technologies, mobile devices and other advanced communications technologies might reduce the frequency and severity of incidents caused by excavation damage?

Response: *PHMSA's current mapping capabilities have an accuracy rate of +/- 500 square feet. While PHMSA would like to pursue more advanced mapping capabilities and accuracies, it requires Congressional support for risk management programs proposed in the Budget.*

[13] https://opsweb.phmsa.dot.gov/pipelineforum/pipeline-materials/index.html

In terms of grass roots outreach, PHMSA continues to raise awareness. In addition, most One Call Centers across the country now allow online web services to submit excavation notices. Regarding underground damage prevention technology, PHMSA supports multiple projects and programs. Examples include the Virginia Pilot Project, State Damage Prevention Grants, Technology Development Grants, and Research and Development. These examples are described below:

- *Virginia Pilot Project: PHMSA partnered with damage prevention stakeholders in Virginia to use existing GPS technology to enhance the quality of communication among excavators and owners of underground facilities.*
- *State Damage Prevention Grants: Established in 2008, these grants are available to states to help align with one or more of the nine elements defining a strong damage prevention program.[14] PHMSA provides grants to help states implement technology that streamlines the safe digging process. The same is true for PHMSA's One Call Grant program and Technical Assistance Grant program.[15]*
- *Technology Development Grant: The purpose of this one-time grant program conducted by PHMSA in 2009 was to make grants to any organization or entity (not including for-profit entities) for the development of technologies that would facilitate the prevention of pipeline damage caused by demolition, excavation, tunneling, or construction activities, with emphasis on wireless and global positioning technologies. Using these funds, a mobile application was developed by Rutgers University to send locate request tickets from excavators to the New Jersey One Call Center. The application allows the users or excavators to enclose an area using shapes like circles, polygons, and polylines over a digital map with satellite view, and to use GPS technology to properly locate and describe the site of excavation.*

15. During your recent visit to Carnegie Mellon University's demonstration of its prototype for a driverless car, it was explained that a human still needs to take over in certain circumstances. A news article also reported that human passengers in test autonomous cars are sometimes prone to motion sickness. Is this true, and has research been conducted on how to keep human passengers engaged in driverless cars?

Response: *Drivers may need to take over control of the vehicle in certain circumstances depending on the capabilities of the system and the driving environment where the vehicle was designed to operate. NHTSA is actively studying how drivers interact with various levels of automated vehicle technologies and the safe timeframes for driver engagement and disengagement. NHTSA recently completed three experiments using Level 2 and Level 3 automated vehicles that explored the need and approaches for bringing the driver back into control of the vehicle. This is a critical research topic in NHTSA's automated vehicles research program. Notably, of the 106 participants in these three experiments, there was not a single case of motion sickness reported by drivers when the vehicles were in self-driving mode.*

NHTSA is not aware of controlled experiments evaluating motion sickness of passengers in automation test vehicles, which could be different from passengers in non-automated vehicles.

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[14] *See* 49 U.S.C. § 60134 (addressing technology in element eight of an effective damage prevention program).
[15] Information about PHMSA's grant programs is available at: https://primis.phmsa.dot.gov/comm/DamagePreventionGrantsToStates.htm#SDPG.

NHTSA is aware of limited survey analysis indicating the possibility of motion sickness as a concern with automated vehicles.

16. Is the current University Transportation Center (UTC) system overly focused on applied research in order to meet the needs of the states, instead of long-term national goals to create transformational technologies? What recommendations do you have to ensure UTCs are conducting research for the greatest benefit of the nation?

Response: *Research under the University Transportation Center (UTC) grants covers the entire range of the innovation cycle, and is one of the few mechanisms within the Department to pursue advanced research. Because so many of the UTCs receive their matching funds from state departments of transportation, UTC research often is driven towards the valuable work of applied research to address immediate problems for the states, although some does support state and local deployment of technologies, and foresight studies.*

The change in matching requirements contained in MAP-21 for the Tier 1 centers, reducing the match to 50%, was a significant first step in enabling UTCs to conduct more advanced research that can meet long-term national goals. Additional steps that could be taken to enhance the environment for advanced research are outlined in the GROW AMERICA Act:

- *Expand the types of Federal funds allowed as match; and*
- *Allow other Operating Administrations to fund UTCs focused on the modal activities of the funding Operating Administration. Such UTCs would be selected as part of the larger UTC competitive selection.*

HOUSE COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY
SUBCOMMITTEE ON RESEARCH AND TECHNOLOGY

"U.S. Surface Transportation: Technology Driving the Future"

Questions for the record, Mr. Gregory Winfree, Assistant Secretary for Research and Technology, United States Department of Transportation

Question submitted by Rep. John Moolenaar, Vice-Chairman, Research and Technology Subcommittee

1. According to NHTSA, deployment of the next major technological innovation for crash avoidance, known as Vehicle to Vehicle communications, or V2V, could prevent as much as 80 percent of all unimpaired crashes on our roads today. V2V and companion technologies, like Vehicle to Infrastructure or V2I, have the potential to revolutionize road transportation as we know it today, saving thousands of lives.

   On May 13, Secretary Foxx announced plans to accelerate the NHTSA rulemaking proceeding expected in 2016 on deploying V2V in the United States and committed to conclude any interference testing on any sharing technology for the road safety spectrum (5.9 Ghz) within 12 months from when private industry provided equipment to the Department.

   Given the budget requests in your submission, do you believe that additional monies may be needed to meet these commitments?
   a. If yes - Could you please provide an estimate of additional funding that may be needed to the Committee.

Response: *The Intelligent Transportation Systems Joint Program Office (ITS JPO) funds and coordinates the Intelligent Transportation Systems Research program, which includes support to the Vehicle-to-Vehicle (V2V) and Vehicle-to-Infrastructure (V2I) research that is enabling the NHTSA rulemaking decision and FHWA V2I Guidance Document. As detailed in the ITS Strategic Plan 2015–2019[16], work to support connected vehicle research and implementation is still necessary to answer questions regarding the operations of a security credential management system and to finalize V2V safety performance requirements.*

NHTSA does not plan to ask for additional resources to meet the Secretary's charge. Accelerating the NHTSA Notice of Proposed Rulemaking and conducting additional spectrum interference testing will be accomplished within existing resources and the anticipated 2016 budgets for both NHTSA and ITS JPO.

[16] http://www.its.dot.gov/strategicplan/index.html

HOUSE COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY
SUBCOMMITTEE ON RESEARCH AND TECHNOLOGY

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Questions submitted by Rep. Dan Lipinski, Ranking Member, Research and Technology Subcommittee

1. Accurate and efficient data collection is key to many of our transportation programs at all levels of government. The data is utilized in the formulation of policies, allocation of capital, and a whole range of important decision for governmental agencies. In particular, travel time is something that's important to everyone. Google Maps travel time indicator is pretty helpful for when I travel throughout my congressional district in the Chicago area, one of the most congested regions in the country. But real-time travel time information is only as good as the data that goes into it. As the old saying goes, "garbage in, garbage out." According to an April 2013 FHWA report, while travel time data collection on freeways is relatively common, that practice is quite rare on non-freeways, such as arterial roads. How can we utilize current or emerging technologies to expand travel time data collection to a broader range and encompass arterial roads? Specifically, can you comment on how current and new technologies, such as inductive loops or "machine vision", can effectively handle travel time data collection on arterials? And then most specifically, how can the federal government encourage the adoption of the best technologies that can ensure that we get the best data possible for arterial road travel times and even from a broader range of data collection needs on our nation's roadways?

Response: *Traditional traffic detection methods, such as inductive loops and other spot-location devices that detect the presence or speed of vehicles, are not effective for determining travel times on arterial roads because of the variations in speeds caused by traffic signals and vehicles that may enter or exit the flow of traffic in between intersections. Newer technologies and techniques that can anonymously identify vehicles or devices through Bluetooth® or cellular communications can capture time-stamps of when the vehicles pass by the roadside readers, and can calculate travel times by comparing the time-stamps. Similar calculations can be made using cameras to characterize and time-stamp individual vehicles at various locations along a route. The increasing use of Global Positioning System (GPS) technology in vehicles and other mobile devices, such as smartphones, allows these devices to share their location and other information. Private companies (fleet managers, application developers) can collect and process this information to determine travel times, and can market the travel time and traffic information to other firms and to public agencies. As more vehicles and devices provide this "probe" information, the travel times become more accurate and useful for traveler information and transportation management.*

All of these techniques have different costs and benefits that must be considered by the agencies that will use the information, to decide on their cost effectiveness. All of these techniques are currently eligible for funding under the major Federal-aid highway programs, as well as potentially under other Federal programs from the Departments of Homeland Security, Justice,

and others. In addition to making sure State and local agencies are aware of Federal-aid eligibility, the Federal Highway Administration (FHWA) will continue to identify and share best practices using methods such as publications, peer exchanges, and workshops. FHWA will also continue to sponsor or co-sponsor research for emerging information technologies, including their independent evaluation to help ensure the quality of the data.

2. Pedestrians, bicyclists, and other non-occupants make up an increasing share of traffic fatalities. How will advancing technologies like Vehicle-to-Vehicle and automated vehicle technologies benefit users outside of cars? What role should ITS JPO, NHTSA or other federal agencies play in ensuring that all people benefit from these systems?

Response: *Bicycle and pedestrian safety is a priority for Secretary Foxx. Recently, Secretary Foxx launched the Department's Safer People, Safer Streets Initiative. The Department will be doing more to address non-motorized safety issues and to help communities create safer, better connected bicycling and walking networks.*[17]

The Department is already developing safety applications that will utilize Vehicle-to-Vehicle (V2V) and Vehicle-to-Infrastructure (V2I) technology to help warn vehicles about the presence of other road users, such as pedestrians and motorcycles. Similarly, new generations of automatic braking technologies that recognize pedestrians and bicyclists and bring the vehicle to a stop if the driver takes no action are being deployed in the light vehicle fleet.

Given the potential for connected and automated vehicle technologies to address so many crash situations, the Department is playing a lead role by developing test procedures and performing evaluations to help ensure that these technologies deliver on their safety promise and are deployed as quickly as possible.

3. Will non-occupants be able to benefit from connected infrastructure through mobile apps? Is there a role for the federal government to ensure that everyone, including low-income and disabled populations, can interact with these technologies?

Response: *Yes, the Department, along with many industry stakeholders, is actively researching an array of connected vehicle technologies and applications, including Vehicle-to-Pedestrian. The Department is laying the groundwork, through standards development and other activities, to facilitate connected vehicle development and deployment, such that all populations may benefit from this life-saving technology.*

4. As connected vehicle infrastructure is deployed, how can we ensure that deployment addresses safety concerns? What is the appropriate balance between safety and congestion concerns?

Response: *The Department and its industry research partners have focused on a combined Vehicle-to-Vehicle (V2V) and Vehicle-to-Infrastructure (V2I) system that would successfully operate at full-scale deployment levels, and in highly congested real-world driving scenarios. The available*

[17] More details at: http://www.transportation.gov/policy-initiatives/ped-bike-safety/safer-people-safer-streets-pedestrian-and-bicycle-safety.

spectrum bandwidth, message sizes, data rates, and other communications details have all been selected and designed to allow for the system to operate in congested vehicle environments to deliver safety of life applications.

All of the Department's research related to demonstrating the communications performance of the V2V and V2I system and ensuring safety benefits has been based on having interference-free use of the spectrum designated by the Federal Communications Commission for vehicle safety communications (specifically, the 5.850 to 5.925 GHz band). The Department believes any sharing of the spectrum should only be allowed if it does not compromise the ability of consumers to depend on the V2V and V2I system.

5. How far of a set back will be experienced to the effort to reduce fatalities, injuries, and traffic delays if the spectrum issue is not resolved in favor of our industry/auto industry/private drivers and their passengers and CDL?

Response: *The Department believes that sharing of the 5.9 GHz spectrum with unlicensed devices should only occur if it can be demonstrated through real-world testing that unlicensed devices do not delay, interfere with, or otherwise impede delivery of information critical to safety of life applications enabled by V2V and V2I Dedicated Short Range Communications (DSRC). The Department is working closely with the National Telecommunications and Information Administration (NTIA) and the Federal Communications Commission (FCC) to ensure that testing and evaluation is completed prior to allowing unlicensed device operation in the 5.9 GHz band. This will avoid any disruption of communications between V2V and V2I devices that could jeopardize the Department's ability to complete the NHTSA rulemaking.*

6. Delphi is at the forefront of demonstrating the technology is available. V2V will be rolling out next year with GM. Self-Driving cars are testing out extremely well. So far, those two initiatives are running almost independently. And the spectrum for V2V is at risk. Do you believe autonomous driving can be made safer by the use of V2X technology, and as such should more work be done to bring the two streams of research together?

Response: *There is an important synergy between connected and automated vehicles, and there is growing consensus in industry*[18] *that connectivity is critical to safe and efficient automated vehicle performance. NHTSA is aggressively pursuing both streams of innovation.*

7. Would you be able to address the future of federal highway funding by means of automated tolling or Vehicle Miles Traveled charge calculations?

Response: *The Administration proposed to retain the current highway fuel taxes and supplement them with a new revenue stream to pay for the GROW AMERICA Act. As part of transitioning to a reformed business tax system that will encourage firms to create U.S. jobs, the Administration's proposal would impose a one-time 14 percent transition tax on the up to $2 trillion of untaxed foreign earnings that U.S. companies have accumulated overseas.*

Federal highway investment has traditionally been funded by revenues from taxes on highway

[18] Bosch, Presentation at Automated Vehicle Symposium 2015, San Francisco, CA.

motor fuels and other highway-related taxes. Inflation, increased fuel economy, and the use of alternative fuels, have eroded the productivity of the Federal highway fuel taxes. Replacing the highway fuel tax with a tax per vehicle-mile traveled (VMT tax) could address the issues of fuel economy and alternative fuels; however, unless the VMT tax is indexed, it would eventually fall prey to lost purchasing power, as has the gas tax. Other challenges to using a VMT tax include collection costs and privacy concerns. Oregon is currently experimenting with options for calculation and collection of a VMT tax that provides choices to participants with the hope of developing a revenue collection design that is acceptable to the public. While Oregon is the furthest advanced in developing a VMT tax structure, other States are conducting research or testing concepts similar to Oregon's program.

Automated tolling holds promise as an option for generating funding at the State and local level, but could be problematic as a Federal funding option. State and local governments own the vast majority of roadways, and toll roads have traditionally been operated by State and local toll authorities (and in some cases, by private toll road operators). With neither ownership rights nor operational access, the Federal government is not well-positioned to raise Federal revenues from these State and local facilities.

8. Very effective and relatively inexpensive collision avoidance technologies are available today for virtually all vehicles currently on the road as an after-market product that can be professionally installed (installation is not always by a dealer), or as a pre-installed feature by the car manufacturers. The after-market devices can provide critical advance warnings to drivers, and the pre-installed technology can even automatically apply the brakes when necessary. This technology is readily available from several companies and it can provide warnings to prevent collisions with pedestrians, other vehicles, bike riders, and joggers. In addition, the technology can loudly alert drivers that they are drifting out of their lane, over the center line or the markings at the edge of a road. Several recent truck collisions were caused by trucks unintentionally veering across center lines. As you know, the National Transportation Safety Board (NTSB) outlined the life-saving benefits of currently available collision avoidance systems in a recent report, and recommended that the technology become standard on all new passenger and commercial vehicles. NTSB's Special Investigation Report, The Use of Forward Collision Avoidance Systems to Prevent and Mitigate Rear-End Crashes, stresses that collision avoidance systems can prevent or lessen the severity of rear-end crashes, thus saving lives and reducing injuries. The report notes that a lack of incentives and limited public awareness has stunted the wide adoption of collision avoidance technology. How can DOT further accelerate deployment of life saving active safety features like these?

Response: *The Department is using all of its available tools to accelerate the safe deployment of these technologies. Some of these crash avoidance technologies, such as electronic stability control and anti-lock brake systems, are already required on vehicles. From critical research programs to the New Car Assessment Program (NCAP), NHTSA has already taken initial steps on technologies such as Forward Crash Warning (FCW), Lane Departure Warning (LDW), and V2V technology, and plans to take steps on systems such as Automatic Emergency Braking (AEB) systems. On these and other advanced technologies, Departmental efforts have included both light duty (passenger cars and light trucks) and heavy duty vehicles (trucks, buses, etc.).*

For aftermarket devices, the Department is actively evaluating how aftermarket systems can utilize

Dedicated Short Range Communications technology to enable an array of driver crash warning applications. In the recent Safety Pilot test in Ann Arbor, Michigan, there were about 300 aftermarket devices deployed and tested.

The insurance industry and the Congress can help to further accelerate the rapid deployment of these technologies through monetary incentives to consumers who purchase these lifesaving technologies.

9. The recent Governors Highway Safety Association report from February 26, highlighted that pedestrian fatalities remained high in 2014. There is a constant stream of stories in the press about buses hitting pedestrians and bicycle riders; or collisions with other vehicles. A few months ago a 15-yr-old girl was hit and pinned underneath a New York City bus. Many collisions involve bus drivers making turns in crowded cities and simply not seeing every jogger, bike rider, or pedestrian at each busy intersection. I think that every parent's nightmare is an accident involving a school bus. Interstate and local bus traffic is increasing greatly and the risks of crashes caused by buses or caused by others hitting buses has to be addressed. As you know there are very effective and relatively inexpensive blind spot collision avoidance technologies available that can be retrofit on any bus or other large vehicle. Studies show that for long vehicles the blind spot is far larger along the side of the vehicle than most pedestrians believe. This technology is readily available from several companies and it can provide warnings to drivers to prevent collisions with pedestrians, other vehicles, bike riders, and joggers. In addition, the technology can loudly alert drivers if they are drifting out of their lane, over the center line, or the markings at the edge of a road. In addition, the alerts can also be heard by pedestrians and cyclists outside the vehicle as well, providing another layer of protection. Such solutions have also proven to substantially reduce fuel consumption costs, due to the positive conditioning effect they have on the habits of drivers. Studies show reductions in fuel use of 8% percent. What can DOT do to promote and accelerate adoption of these important technologies?

Response: *The Department agrees that pedestrians being struck by vehicles is a safety problem with potentially tragic consequences. Blind spot systems, as advertised today, are designed to detect adjacent vehicles, not pedestrians. NHTSA has performed multiple evaluations of sensor-based object detection systems and close-to-vehicle pedestrian collision avoidance technologies for multiple types of vehicles, including systems designed specifically for school buses. To date, these systems have not been proven to be very effective. However, new systems are emerging, and should resources permit, NHTSA anticipates evaluating these newer systems.*

One of the most effective countermeasures protecting pedestrians and bicyclists is truck side guards. Truck side guards are vehicle-based safety devices designed to keep pedestrians, bicyclists, and motorcyclists from being run over by a large truck's rear wheels in a side-impact collision. The John A. Volpe National Transportation Systems Center (Volpe Center; Cambridge MA; part of the Office of the Assistant Secretary for Research and Technology) is advancing this technology's adoption in the United States by conducting research and partnering with cities to help deploy side guards and other technologies that address the deadliest road crashes: those between large trucks and pedestrians or bicyclists. Volpe is also building a national network of early adopters in the area of truck side guards and other truck safety technologies related to

pedestrians, bicyclists, and motorcyclists.[19]

10. There is so much publicity about the seemingly daily incidents-collisions between large vehicles and pedestrians/cyclists. However, the process of evaluating and implementing pedestrian detection/collision avoidance technology for pedestrian/cyclist safety as well as other safety measures in the public transit world is fraught with hurdles. Funds should be more readily allocated, first for evaluation and finally for implementation upon acceptance. What is the FTA doing to focus public entities on embracing pedestrian detection/collision avoidance safety technology?

Response: *The Federal Transit Administration (FTA) regularly conducts outreach through webinars, publications, workshops, and conferences to educate the transit industry about emerging technologies and has a number of activities in support of pedestrian/cyclist and vehicle safety recently completed or underway, as described below.*

FTA has been conducting research in pedestrian detection/collision avoidance safety technology for many years through the Intelligent Transportation Systems (ITS) Joint Program Office (JPO) Connected Vehicle Safety program. FTA has conducted an Analysis of Collisions Involving Transit Vehicles and Applicability of Connected Vehicle Solutions to guide in prioritizing the applications developed. Although transit is a very safe mode, the analysis provided information on both frequency and cost of collisions. Collisions with pedestrians, although not very high in frequency, incur the highest costs to transit providers per event. Unfortunately, cost and technical capacity at the transit agency level continue to be barriers to procuring and implementing these systems.

FTA participated in the Department's Safety Pilot Model Deployment by developing, installing, evaluating, and modifying several prototype safety applications for transit buses, including an application that uses V2I Dedicated Short Range Communications to warn bus drivers of potential collisions with pedestrians in crosswalks at signalized intersections. Results revealed that improvements must be made to the application to increase its performance to an acceptable level. FTA recently provided funding to the contractor to improve the application. In addition, in partnership with the ITS JPO, FTA is planning to develop and evaluate a similar application to warn bus drivers and pedestrians when buses approach and depart at major bus stops. FTA has organized a stakeholder steering group, consisting of representatives from transit agencies and other public agencies, transportation industry associations, and technology vendors, to disseminate knowledge and to obtain input concerning these efforts.

Recently, FTA has undertaken a research study on commercially available pedestrian warning systems for transit buses. The intent of this research is to assist the transit bus industry in making informed decisions regarding the implementation of the turn warning systems, and in understanding the shortcomings and the potential pay-off of an investment of this type. This assessment of bus turn warning technologies is the first of its kind and will provide transit industry stakeholders with a significant amount of information not previously available in a formal, comprehensive, public document. FTA has plans to expand its existing research portfolio to study the feasibility and effectiveness of adapting commercially-available pedestrian/bicyclist safety products from the automobile sector to a transit environment.

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[19] More details at Volpe's Truck Side Guard Resource Page: http://www.volpe.dot.gov/our-work/truck-side-guards-resource-page.

Finally, Secretary Foxx, as part of his Safer People, Safer Streets Initiative, directed Department staff to plan and implement multi-modal bicycle-pedestrian safety assessments.

11. Many public transit entities are either completely self-insured or self-insured up to a certain cap. Has this cost been looked at as part of the calculus regarding technology implementation? Has the insurance industry been engaged to become involved regarding pedestrian detection/collision avoidance safety technology around large vehicles?

Response: *Liability costs are part of the calculus provided by the Analysis of Collisions Involving Transit Vehicles and Applicability of Connected Vehicle Solutions. The insurance industry has taken notice of the potential benefits and is engaged through the Emerging Technologies Law Committee at the Transportation Research Board (TRB).*

In 2009, RAND published a report featuring a discussion of the liability of automated vehicle drivers, insurers, and manufacturers entitled "Liability and Regulation of Automated Vehicle Technologies." Several recent academic legal papers have focused on the liability of drivers and manufacturers. Gary E. Marchant and Rachel A. Lindor wrote one such paper entitled "The Coming Collision between Automated Vehicles and the Liability System." Bryant Walker Smith argued in "Proximity-Driven Liability" that contractual and technological developments that make sellers and their upstream suppliers closer to their products could also increase their liability.

The Department, in cooperation with TRB, will continue to conduct analysis and explore policy options that support decisions on the Federal role and authority, liability and limitations to risk, policy and practices regarding privacy, and policies on intellectual property and data ownership within the connected vehicle environment, among other legal issues. As products emerge, liability issues will be at the forefront in the ability to deploy these innovations.

12. Have temporary work zones been taken into consideration when deploying V2X? For instance, it's one thing to be able to have the vehicle interact with fixed roadside hardware, but it's another issue for work zones which might only be in the road for a short duration.

Response: *The presence of temporary work zones presents unique challenges in developing V2X solutions, and FHWA is actively involved in ensuring that V2X deployments take work zones into account. A primary concern is that any hardware or systems designed to communicate between vehicles and the infrastructure must be responsive to dynamic and real-time changes in the geometric, regulatory, and operational road environment arising from a temporary work zone.*

Accordingly, in developing and promoting work zone-friendly connected vehicle (or CV) technologies, FHWA is leading a variety of strategies. Some of these strategies include the inclusion of work zones in the V2I Safety Applications Concept of Operations (FHWA-JPO-13-060), which serves as a foundational document for FHWA's role in developing CV technology. Also, the FHWA V2I Deployment Guidance, expected in fall 2015, will include work zone related applications. This guidance is intended to assist FHWA staff and transportation system owner/operators with deploying V2I technology.

FHWA is also developing technology applications geared to providing improved traffic responsiveness to the presence of work zones downstream, such as the Speed Harmonization (SPD-HARM) and Queue Warning (Q-WARN) applications being developed through the Dynamic Mobility

Applications (DMA) program. FHWA is engaging private-sector innovation in developing CV technology specific to work zones through projects such as the Delivering In-Vehicle Messages in Temporary Work Zones project supported by the Department's Small Business Innovation Research (SBIR) program.

The Department has entered into a Cooperative Agreement with the Texas Department of Transportation to develop, evaluate, and test systems and applications to provide travelers with real-time information regarding work zone activity, lane closures, incidents, and queues as part of V2I communications for safety, mobility, and environmental performance along a long-term work zone on I-35. FHWA is also continuing research into the state-of-the practice regarding how agencies and private-sector entities collect, process, and distribute/share real-time work zone data.

13. The American people, the public transportation industry, and Congress all desire more efficient use of federal funds in the form of innovative construction methods such as P3's and the development of asset management practices. However, we have seen a steady and sharp reduction of research and development funds available through the TCRP in recent years which has negative impacts on innovative research efforts. Our national transportation policy goals involve things such as i.e. more carbon friendly modes of transport, improved safety for transit, and improved cost efficiencies. If we want to achieve these goals, the trend of declining TCRP investment must be reversed. In addition to increasing program investments, do you have any suggestions or thoughts on what else Congress can do to create more efficient federal transportation research programs? How can we get more bang for our buck when it comes to transportation research? What can we do so that our transit agencies reap greater benefits from cutting edge research?

Response: *Declining levels of funding for the Transit Cooperative Research Program (TCRP), the transit discretionary research program, and the technical assistance and standards program has limited FTA's success in advancing emerging technologies in the provision of transit services to the American people. TCRP, managed for FTA by the Transportation Research Board, is user-initiated research that addresses directly the most urgent research needs of the transit operations community. Reductions in TCRP have hindered FTA's ability to address swiftly new and emerging technical issues. The overall reductions in transit research impair FTA's ability to deliver on its promise of comfortable, effective, accessible, environmentally sustainable, and economically efficient transport.*

In order to create a more efficient Federal transportation research program, Congress could support and strengthen FTA in its unique, central role as the custodian of a nationally coordinated research enterprise by fully funding the President's request of $60M for Transit Research and Training as reflected in GROW AMERICA and the FY16 Budget Request. As the only Federal organization that has a national perspective on transit operations, transit industry needs, and the impact of new practices and technologies on those operations, FTA serves the transit industry by supporting (1) research activities that improve the safety, reliability, efficiency, and sustainability of public transportation by investing in the development, testing, and deployment of innovative technologies, materials, and processes; (2) the Transit Cooperative Research Program, which provides funding to the National Academy of Sciences to conduct investigative research on subjects related to public transportation; (3) technical assistance to the public transportation industry, with an emphasis on improving access for all individuals and transportation equity; and (4) human resource and training activities within the transit industry,.

14. The IDEA program at TCRP has documented an astounding ROI for the industry, in part because of strong industry engagement. Would FTA's research benefit from more industry guidance and engagement? How can industry engagement be restructure or improved to increase technology adoption from FTA's research?

Response: *Yes, FTA's research program benefits tremendously from industry engagement, and is seeking to increase and formalize that engagement. FTA is in the process of engaging the industry by re-establishing the Transportation Research Analysis Committee (TRAC), and FTA plans to engage with industry representation as it pursues future research and technology projects. Additionally, FTA will be engaging the industry in an upcoming on-line dialogue on several program areas, one of which is specifically related to technology adoption.*

Through TRAC and other means, FTA is interested in advancing a stakeholder engagement process to directly solicit the transit industry about the technology (and other) related research/ demonstrations it needs to improve its daily transit operations. In addition, FTA believes it is critical to educate the industry on the eligibility of proven technologies under FTA's formula programs as a mechanism to increase technology adoption from FTA's research program.

HOUSE COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY
SUBCOMMITTEE ON RESEARCH AND TECHNOLOGY

"U.S. Surface Transportation: Technology Driving the Future"

Questions for the record, Mr. Gregory Winfree, Assistant Secretary for Research and Technology, United States Department of Transportation

Questions submitted by Rep. Elizabeth Esty, Member, Research and Technology Subcommittee

1. How does the Department of Transportation measure its progress in moving successful Research and Development into deployment? For example, I'm aware there has been significant DOT funded research into building bridges cheaper and faster. Can DOT tell us how much money that research has saved us?

Response: *The value of the Department's research toward building safer bridges for less is seen in the development of large and small innovations in materials, designs, policies, operations, and safety on the highway system. Deployment of those innovations enables the highway system to move people and freight efficiently and contributes to the economic success of the United States.*

The Federal Highway Administration (FHWA) plays a key role in leading the national transportation research and development needed to meet the challenges now and in the future. FHWA's Every Day Counts (EDC) initiative[20] identifies and rapidly deploys innovations (technologies)—products of research and development—to shorten the highway project delivery process in addition to providing improvements in design and serviceability. Accelerated bridge construction technologies enable highway agencies to replace bridges in hours and reduce planning and construction efforts by years, significantly reducing traffic delays and road closures and lowering project costs. Road diets, also known as roadway reconfigurations, offer high-value, low cost improvements when used to convert an existing four-lane, undivided roadway segment to a three-lane segment with a center, two-way left turn lane to improve safety and better accommodate all users by providing space for pedestrian refuge islands, bike lanes, sidewalks, bus shelters, parking, or landscaping.

The Department's R&D progress is evident as state DOTs adopt and implement EDC's identified technologies. A few examples of recent successes include:

- *Geosynthetic Reinforced Soil-Integrated Bridge System (GRS-IBS): Massachusetts DOT's first GRS-IBS project was the replacement of the State Route 7A Bridge over the Housatonic Railway in Sheffield. Using GRS-IBS on the $1.1 million project saved 49 percent of the estimated cost of the original design using conventional construction. Defiance County, Ohio, can typically construct two bridges for the cost of a single bridge built with pile supported abutments.*

- *Prefabricated bridge elements and systems: Rhode Island DOT replaced the 57-year old Frenchtown Brook Bridge using a prefabricated superstructure, substructure, and foundation*

[20] For more details on projects and cost savings, please visit FHWA's EDC website: http://www.fhwa.dot.gov/everydaycounts/.

systems. The new bridge was prefabricated away from the construction site before installation. This innovative approach increased safety, enhanced quality, and allowed the contractor to replace the bridge during a 33-day road closure instead of the six months required for traditional methods. A comprehensive economic analysis including user costs shows that the project saved road users about $2 million.

- *Slide-in bridge construction: Connecticut DOT (CTDOT) replaced twin structures on I-84 in Southington using slide-in bridge construction. Instead of inconveniencing the public for two construction seasons, CTDOT shut down I-84 over a weekend to replace both structures and opened them to traffic 13 hours ahead of schedule. CTDOT's new policy requires staff to use a decision matrix on all bridge projects to determine whether accelerated bridge construction is applicable.*

- *A Road Diet applied in Orlando, Florida, converted an existing four-lane undivided roadway segment into a three-lane segment consisting of two through lanes, a center two way left turn lane; and installed bike lanes. The result was a 34 percent reduction in the total number of crashes, a 30 percent increase in bike volumes, and a 23 percent increase in pedestrian volumes.*

- *A Des Moines, Iowa, Road Diet also provided a benefit to buses: instead of stopping in a through lane and blocking traffic as they had done before the reconfiguration, the new design accommodated them with a bus turn out.*

Outside of EDC initiatives, high end computational modeling is helping to solve problems faster and with greater accuracy. After the 2013 Colorado floods, FHWA's Turner-Fairbank Highway Research Center was asked to analyze and report on new designs within a short timeframe due to the urgency, which would not have been possible without computational capabilities. This capability saved the State time, money, and lives as it was able to deliver performance results on new scour/flood protection measures.

High-performance modeling capabilities were utilized to assist the U.S. Army Corps of Engineers L.A. District in optimizing the pier design of its Burlington Northern and Santa Fe Railroad Bridge over the Santa Ana River downstream of Prado Dam in Riverside County, California. This research helped in optimizing the design for this scour critical bridge in additional to satisfying environmental constraints, preserving the habitat of the endangered Santa Ana Sucker fish. The streamlined design saved the Corps approximately $20 million.

HOUSE COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY
SUBCOMMITTEE ON RESEARCH AND TECHNOLOGY

"U.S. Surface Transportation: Technology Driving the Future"

Questions for the record, Mr. Gregory Winfree, Assistant Secretary for Research and Technology, United States Department of Transportation

Questions submitted by Rep. Paul Tonko, Member, Research and Technology Subcommittee

1. The research being done on connected vehicles provides a great opportunity to improve transportation safety and energy efficiency. I know the Administration has made significant investments in this field and proposed even more in the GROW America Act. I am particularly interested in Vehicle to Infrastructure (V2I) technologies. Some V2I technology is ready right now to be deployed but would require significant regional cooperation-across multiple state, county, and municipal boundaries-to effectively implement and integrate. Moving forward, what will be the benefits to having local, regional, and state authorities coordinate and standardize their V2I deployments? What should be the federal role in that?

Response: *Coordination and interoperability are critical to the safety and success of vehicle-to-infrastructure (V2I) applications and technology. Since vehicles may traverse all parts of the country, applications that rely on V2I connectivity will only function properly if there is roadside equipment that is interoperable in communicating with the in-vehicle equipment. Among the benefits of coordination are improved regional and wider-area information for vehicle operators to allow them to make more informed decisions about their routes. Coordination will also provide transportation agencies the capability to develop and implement strategies for better area-wide transportation management. Continuing its current role, the Federal government is identifying standards necessary for interoperable V2I communications, establishing requirements for testing and certifying interoperable equipment, and as necessary, establishing requirements for federally-funded V2I equipment.*

2. I appreciate your comments about DOT's willingness to test the feasibility of sharing the 5.9 gigahertz band of spectrum between Intelligent Transportation Systems (ITS) and unlicensed Wi-Fi devices. Many seem to believe that through open cooperation and planning, safe sharing in the 5.9 band can be realized. But safety must remain our top priority. Is DOT committed to testing in an open and collaborative manner Dedicated Short Range Communications frequency sharing with unlicensed devices in all or part of the 5.9 band? If so, what actions has DOT taken to engage stakeholders representing unlicensed devices?
    a. Will the data generated at the Cheltenham facility be made available to stakeholders representing unlicensed devices?

Response: *The Department has been actively engaged with Federal and industry stakeholders for over 18 months (since the inception of the IEEE Tiger Team) to understand the characteristics of spectrum sharing as a basis for developing a spectrum interference test plan. The IEEE Tiger Team allowed for the identification of sharing concepts and further allowed the Department to*

solicit industry for devices that demonstrate spectrum sharing capabilities for testing. The Department continues to work closely with the Federal Communications Commission (FCC) and National Telecommunications and Information Administration (NTIA) to establish test plan requirements.

The Department is aware that any sharing mechanisms provided by industry for testing will be developmental and may involve proprietary information. Federal regulations necessarily restrict release of proprietary information beyond the submitter of the technology and Federal agencies. If test results reveal that an acceptable sharing mechanism is found, data showing performance and sharing will be made available, while protecting the proprietary information. The Department will use these test results to work with the FCC to develop rules, through their public comment process, that support implementation of a test-proven sharing mechanism. This approach applies to data collected at the Federal Law Enforcement Training Center (FLETC) in Cheltenham, Maryland.

3. MAP-21 contained a provision called Jason's Law to conduct a truck parking survey. We know the lack of available and safe parking for truck drivers is a serious problem, and I hope this inventory of assets will encourage states to invest more in parking. What innovations are out there that can bring greater efficiency to parking and provide information to drivers on space availability? Is there any research being done to look into this?

Response: *Safety is the Department's number one priority and we recognize there is a significant truck parking problem across the nation. MAP-21 required the Secretary of Transportation to conduct a survey and comparative assessment to: evaluate the capability of each State to provide adequate parking and rest facilities for commercial motor vehicles engaged in interstate transportation; assess the volume of commercial motor vehicle traffic in each State; and develop a system of metrics to measure the adequacy of commercial motor vehicle parking facilities in each State. FHWA partnered with the American Association of State Highway and Transportation Officials (AASHTO), with input from public motor carrier safety, private trucking, and truck stop representatives, to complete the survey. The Department is now finalizing the comparative assessment.*

SAFETEA-LU's "Truck Parking Facilities Pilot Program" provided funding for at least ten truck parking projects with a technology element across the nation. These projects were able to test the usefulness of various Intelligent Transportation Systems technologies on different corridors. Among these were Michigan DOT's I-94 Truck Parking Information and Management System (TPIMS), which assesses truck parking along the I-94 corridor. The system shares parking availability information through dynamic roadside truck parking signs, a website and smartphone applications, and directly to a fleet of pilot trucks equipped with on-board connected vehicle equipment. Minnesota DOT also equipped three rest areas in the state with automated truck stop management systems using video detection systems that convert capacity information to a web-based application so truck drivers and law enforcement can know when spaces are available with about 95 percent accuracy.

A number of other projects have been undertaken in Virginia and Maryland, and in other parts of the country. While the information gathered through these research programs provide best practices and lessons learned that can be used by other State DOTs, the truck parking problem cannot be solved without involvement and investment by the private sector in expanding capacity as well as improving the communication of truck parking availability. State DOTs should continue to work with private truck stop operators and the trucking community to encourage the continued

development of truck parking solutions.

4. After the tragic fatal Amtrak derailment last month, those of us in the northeast want to know what research is being pursued to improve passenger rail safety in addition to Positive Train Control (PTC). Are there additional things that can be done to improve passenger and freight rail safety? I mention freight rail because my district, like many throughout the country, is experiencing an influx of rail carrying crude oil. Aside from enhanced braking and other improved safety standards that have been proposed in DOT's recently released High Hazardous Flammable Train Rule, what else can be done on the operation or inspection front to ensure these trains operate as safely as possible? Please provide examples of what research is being planned or is underway to improve passenger and freight rail safety.

Response: *Safety data shows that broken rails are the most common cause of train derailments. The Federal Railroad Administration (FRA) has researched this problem for several years and is currently developing new technology for improved detection of rail defects before they become failures. FRA is also revising its rail inspection regulations to require increased rail inspection frequencies.*

Human error has been shown to be the cause of about a third of all train accidents and incidents. FRA has implemented the Confidential Close Call Reporting System to improve safety culture in the industry and to take action to avoid human errors. FRA is also funding the Short Line Safety Institute to conduct assessments and provide training to improve safety in short line and regional railroads. Further, FRA is working on rulemakings to address human factors including fatigue, and inward- and onward-facing cameras. In addition, FRA is piloting use of technology to detect the use of personal electronic devices (cell phones, etc.) in locomotive cabs that cause distractions.

FRA has also conducted several years of research and development to improve requirements for passenger rail car structural integrity. This has resulted in new equipment being procured and going into service that provides significantly better crashworthiness. Work is ongoing to improve glazing standards and to further protect rail passengers in accidents.

FRA has recently revised its Track Safety Standards for speeds above 90 mph for passenger equipment and 80 mph for freight equipment. This work is ongoing to improve safety standards for lower speed operations. FRA has developed new technology for the continuous inspection of track quality to ensure compliance with its regulations.

Responses by Dr. Michael Meyer

HOUSE COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY
SUBCOMMITTEE ON RESEARCH AND TECHNOLOGY

"U.S. Surface Transportation: Technology Driving the Future"

Questions for the record, Dr. Michael Meyer, Chairman, Research and Technology Coordinating Committee, National Academies' Transportation Research Board

Questions submitted by Rep. Barbara Comstock, Chairwoman, Research and Technology Subcommittee

1. *In your opinion, does the Office of the Assistant Secretary of Research and Technology effectively fulfill its mission and responsibilities? In what specific ways might the office be improved?*

The Office of Research and Technology has many roles. I think two of the most important are coordinating the other research efforts in the Department that occur in the modal agencies, and developing a strategic vision/road map for what the national transportation research program should be (recognizing that the USDOT does not have to do it all). With respect to the first, my understanding is that the Office is playing an upfront role in coordinating (or at least fostering communication between) the different modal research efforts. The respective Associate Administrators for Research and Technology Development do meet regularly to exchange information on what their programs are doing and how they can better coordinate. From my perspective, this has happened much more than it has before. My only concern is that the effort seems related to the personalities involved than any programmatic structure for doing so. In other words, the respective individuals work together well and seem predisposed to developing a Departmental research strategy. I am not sure what might happen if different people were in the leadership positions.

With respect to leadership on a national transportation strategy and road map, I think there is room for improvement. The Office has made important strides in defining and articulating needed research to enhance the performance of the nation's transportation system. In my mind, we are at a turning point in the future of transportation. Historically, one can look at similar such turning points, most of which have to do with the application of different propulsion fuels. I would argue that new technology applications represent such a turning point...even to the point of not having to travel at all because of technology options available to accomplish some task (e.g., electronic banking). And much of the research and technology development that will lead to changes in our transportation system will come from private companies, notably automobile manufacturers. We need to rethink the strategy of how to harness the creativity and industriousness of the private sector and quite frankly of our younger generation. In Singapore, the transportation authority once a year holds a competition for those developing new apps for using the transportation system to encourage innovation and creativity. The databases developed by the authority are available to the entrepreneurs, which are necessary for the apps to work (unlike some agencies in the U.S. that don't allow access to their databases). As a result, the Singapore

transportation system is one of the easiest to use in the world. I would like to see a thoughtful, forward-looking strategy based on partnerships that defines what the U.S. should be doing in transportation research. Such a statement might even serve as a guide for the focus of the UTC program (see below) and as a way of prioritizing DOT's own research efforts.

2. *As we move toward a world where autonomous vehicles are the norm, how would you define the "operator" of the vehicle, and who would you hold liable in accidents? What other legal issues need to be considered relative to autonomous vehicle technologies?*

This is a very good question and one that still has not been resolved. In my opinion, once the control of a vehicle is turned over to another party, they hold liability for what happens. Now, of course, a driver has control of a vehicle and if something happens while he/she is in control, they are held liable. If control is given to the vehicle, which was manufactured to have such control technology incorporated into vehicle operations, and if such technology is also relying on vehicle-to-infrastructure information provided by government agencies, how can an owner of the vehicle be held liable if something goes wrong? Unfortunately, my sense is that this issue is going to be the subject of much litigation and that eventually legal precedence will define the operating environment.

I am not a legal expert so I do not know what other types of legal issues might be associated with autonomous vehicle technologies. I really think that the liability issue is the most important.

3. *Is the current UTC system overly focuses on applied research in order to meet the needs of the states instead of long-term national goals to create transformational technologies? What recommendations do you have to enable UTC's to conduct research that provides the most benefits to the nation?*

I was on the very first advisory/selection panel for the UTC program in the 1980s and have watched the program evolve over the past 35 years. It has been interesting to watch the program change to reflect evolving program goals. At the very beginning, the focus was on conducting research that was "in the national interest." The latest competition provided for three categories—national centers focused on U.S. DOT goals, regional centers and tier 1 centers. I agree with the statement that the UTC program has been focused on applied research to the detriment of more longer-term research. This has been primarily due to the fact that matching dollars most often came from state DOTs and they have been mainly concerned with research that could benefit their program and operations. This has not surprisingly led to applications-oriented research. There are some centers, Carnegie-Mellon, University of California-Berkeley, University of Florida to name a few, that have contributed to our knowledge of new technologies and how they can transform the country and the transportation sector. However, for the amount of funding associated with the UTC program, it

seems to me that there should be more interest in, and attention to, the transformational technologies that will be part of our future. This is not only in the vehicle and infrastructure topics, but as well in the information systems, hand-held technologies, GPS, and other technology applications that could provide a more productive and efficient transportation system. Having been a professor for many years, I have been amazed at the ingenuity and creativity of the younger generations on what is possible with respect to technology.

With respect to ensuring the most benefits to the nation, I think the UTC program needs to be more targeted on specific topics. At last count, I think there are 34 universities that hold a lead position in a center, and there must be close to 70 or 80 other universities that are part of a consortium. I am not sure that this model provides the targeted focus that will lead to the transformational research that should be part of a national transportation program. I fully acknowledge the educational benefits that accrue to having such a large number of universities involved with the program....the graduate students of today are the transportation professionals of tomorrow, so we should not discount this component of the program. What I would do is provide a more targeted focus on some of the UTC programs that relate to the types of issues that the nation is facing on the future of the transportation system. The USDOT has done this in the most recent solicitation, but it was done at a fairly high level of policy focus, e.g., we want a center on safety, we want a center on environmental sustainability, etc. I would target some dollars (not all) on very specific issues, e.g., we want a center on new mobile apps for users of the transportation system, we want a center on crash avoidance systems for vehicle-pedestrian crashes, etc. In this way, you have targeted a critical sum of dollars on issues that will truly advance the state-of-the-art.

HOUSE COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY
SUBCOMMITTEE ON RESEARCH AND TECHNOLOGY

"U.S. Surface Transportation: Technology Driving the Future"

Questions for the record, Dr. Michael Meyer, Chairman, Research and Technology Coordinating Committee, National Academies' Transportation Research Board

Questions submitted by Rep. Dan Lipinski, Ranking Member, Research and Technology Subcommittee

1. *How can we utilize current or emerging technologies to expand travel time data collection to a broader range and encompass arterial roads? Specifically, can you comment on how current and new technologies, such as inductive loops or "machine vision" can effectively handle travel time data collection on arterials? And then most specifically, how can the federal government encourage the adoption of the best technologies that can ensure that we get the best data possible for arterial road travel travel times and even from a broader range of data collection needs of our nation's roadways?*

   The collection of data on how the transportation system performs is fundamental to transportation planning and planning for operations. For many years, the focus of the data collection efforts has been on the infrastructure side, that is, let us count how many vehicles or passengers pass a certain point. Inductive loops and "machine vision" are two examples of this approach. These are location-specific data collection technologies provide the planner with information on what is happening at a specific location. For travel time or determination on arterials (for speed, if given a known distance traveled one can determine travel time), one would need the ability to note the time a vehicle passes a given point and then when that vehicle passes another point with a known distance between. Machine vision, for example, can identify the distance traveled by a vehicle and the time between images to determine speed. Inductive loops would require knowing the distance between the loops and the time taken to travel between two loop locations. If the inductive loops are far apart some way of making sure it is the same vehicle being measured would also have to be available. On arterial roads, this would require much more investment in detection technologies than found today.

   In comparison, I would argue that the transportation field is evolving to a vehicle or passenger-based travel time estimation. The INRIX data on truck movements, for example, is being used by many agencies to determine travel times and speeds. The technology is very straightforward and is based on GPS tracking. Importantly, when combined with GIS platforms transportation planners can identify which roads the vehicles are traveling on. Similar types of approaches have been applied to pedestrian, bicyclist and transit riders. Note that vehicles and persons could be tracked on all roads,

not just the major arterials and above. This gets away from the need to have monitoring equipment on all roads.

My sense is that the federal government has already put in place the ability to collect such data through the congestion management process (CMP) that is required for all urbanized areas over 200,000 population. Speed calculations (or travel time) are a necessary input into the development of the CMP plan, and it certainly makes sense to require that travel times and speeds that are collected as part of the CMP should be based on the latest data collection technologies. Of course, as we evolve into a more "connected" network, the vehicles themselves become moving data points (called probe vehicles) that can be the source of travel time and speed information (as long as privacy information is protected). It might make sense for the federal government to allow such data collection to occur from private vehicles with appropriate safeguards for privacy concerns.

2. *How will advancing technologies like Vehicle-to-Vehicle and automated vehicle technologies benefit users outside of cars? What role should ITS JPO, NHTSA or other federal agencies play in ensuring that all people benefit from these systems?*

The stated purpose of V2V and automated vehicle technologies has been primarily on improved network efficiencies and enhanced safe operations (usually focused on vehicle-to-vehicle crashes). Very little focus (in my opinion) has been given to non-vehicle users and the benefits that might accrue to them. Improved safety would be an obvious potential benefit. The concept of the autonomous vehicle is that it can move from one location to another without hitting an object, such as a pedestrian or a bicyclist. As the advocate for all transportation system users, the U.S. DOT should make sure that the non-vehicle users of the transportation system should be included in the technology approaches being developed. I am not that familiar with the actual technologies and their capabilities but it seems to me that sensors and imaging technology would need to have the capability to identify and react to potential pedestrian and bicycle conflicts with the vehicle. As the V2V and V2I technologies evolve, at some point, state DOTs and the federal DOT will have to establish the basic criteria for safe operation on the U.S. road system. Several states have already passed laws that allow safe autonomous operations, but I am not sure that the laws actually lay out what must happen for such operations to be allowed on public highways.

With respect to ITS JPO, NHTSA, FHWA, and FTA, each has been given some form of safety mandate, some more influential than others. I think the federal U.S. DOT must be upfront and early in making sure that the technologies being tested have the abilities to identify and avoid conflicts with non-vehicle users of the road. For example, the federal government could establish minimal safety standards for V2V operations on the national interstate system as they relate to operations (although pedestrian and bicyclists would presumably not be a big issue on interstates). In addition, the U.S. DOT could require a re-examination of the ITS system architectures and concept of operations developed in response to ISTEA that specifically includes safety or other benefits to non-vehicle users.

3. *Will non-occupants be able to benefit from connected infrastructure through mobile apps? Is there a role for the federal government to ensure that everyone, including low-income and disabled populations, can interact with these technologies?*

   Mobile apps are here to stay....and everyone will likely benefit from their continued development. Interestingly, surveys have shown that low-income and minority households use smart phones more than white households do. Thus, their exposure to apps on transportation system performance and operations is potentially very high. I believe in the creativity and ingenuity of the younger generation who has grown up with technology and are developing all sorts of new ways to make daily life easier. I have no doubt that they will develop apps that will be available to everyone. The best role for the federal government is to make sure that the data (often collected with federal dollars) is available to the public for the development of apps. This might mean limiting liability issues to those who use public data for their apps.

4. *As connected vehicle infrastructure is deployed, how can we ensure that deployment addresses safety concerns? What is the appropriate balance between safety and congestion concerns?*

   I am of the opinion that safety always comes before congestion. A study I did several years ago showed that the economic value of lost lives, property damage and lost time to others from crashes far exceeds the economic value of lost time due to congestion. The concern for safety has to be part of every standard, operations protocol, design plan, and strategy adopted to implement connected infrastructure efforts. The U.S. DOT should adopt such a policy (if it hasn't already done so), and any protocols or standards developed for application of connected infrastructure should state clearly that safety is the biggest issue.

5. *How far of a setback will be experienced to the effort to reduce fatalities, injuries and traffic delays if the spectrum issue is not resolved in favor of our industry/auto industry/private drivers and their passengers and CDL?*

   The technological foundation for the V2V and V2I strategies is having a dedicated communications spectrum to allow for interactions to occur. If such is not available, the setback to safety and reducing traffic delays will be dramatic (and traumatic). This is the key to making everything else happen.

6. *Do you believe autonomous driving can be made safer by the use of V2X technology, and as such should more work be done to bring the two streams of research together?*

   In my opinion, autonomous vehicles can be made a lot safer with V2X technologies. My fundamental principle on the feasibility of autonomous vehicle operations is that the more information made available to the vehicle "intelligence," the better the vehicle will operate in the network. This will especially be important when such vehicles mix with vehicles that do not have such technology (if some form of dedicated right-of-way is not available to autonomous vehicles). This means that efforts should be made to bring the

two streams of research together, at least in ways that promote an understanding of how one research focus can benefit the other. This is a good role for the U.S. DOT.

7. *Would you be able to address the future federal highway funding by means of automated tolling or vehicle miles traveled charge calculations?*

I have publicly stated and written an editorial for CNN on the likely evolution of our transportation funding toward a VMT-based fee. I think it makes sense and the technology is such that is can be done (if the federal government provides some oversight to assure standard approaches). I have been criticized because of this stance from those who don't like "big brother" knowing how much travel is occurring in individual vehicles, but his can be handled with personal privacy laws. What is perplexing to me is the criticism I received from those who claim that this will discriminate against those who travel longer distances. In reality we already have a distance based fee structure. Whenever you pay for a gallon of gas, and given the fuel efficiency of the car, you are paying a VMT tax. The more one travels, the more gasoline consumed and the larger cost to the traveler....exactly the same concept as the VMT fee. Of course, many are worried that once "government" has its foot in the door, it can raise the per mileage fee above what a gas tax would do. Watching how difficult it is for elected officials to raise the gas tax, I have to think it will be as difficult to raise a per mile charge. I am not sure automated tolling will be feasible nationwide on all roads, which the VMT fee would be able to do.

With respect to how much one could raise, it all depends on the per mile fee. The Oregon demonstration of the technology for doing VMT fees was designed to keep the overall cost to consumers the same as they would have faced if they simply paid the gas tax. The benefit of using a VMT fee is that ALL vehicles will pay, even those that are using alternative fuels and electric vehicles. This is an issue because an argument could be made that not paying a gas tax and for that matter per gallon charges makes such vehicles more affordable. I don't buy that argument. Everyone using transportation infrastructure should have to pay for their use, not matter their fuel or propulsion energy. If such is the case, this would increase the level of funding available for the federal aid highway program.

8. *How can DOT further accelerate deployment of forward sensing crash avoidance technology deployment and other life saving features like these?*

The automobile industry has been aggressively pursuing and marketing such technologies to sell their vehicles. It takes time for the vehicle fleet to turn over (14 to 17 years), so I suspect we will see a fleet in the year 2030 that is largely equipped with

such technologies. If you want to accelerate deployment, the federal government can mandate their application, similar to what has been done for backward motion sensors and imaging technologies. At a very minimum, the U.S. DOT can provide marketing, and educational materials that focus on the benefits associated with such technologies. I would like to see demonstrations and pilot studies that actually quantify the benefits.

9. *What can DOT do to promote and accelerate adoption of pedestrian/bicyclist/bus crash avoidance technologies?*

   This is an area that has not received as much attention as the V2V crash avoidance technologies, and is one that much more work is needed. The FTA has been working with the transit industry to explore the different approaches that can be implemented. I believe FTA has a demonstration project in Portland that is looking at this very issue. However, as stated above I think this issue has been neglected. I would fund pilot studies and demonstration projects to examine different ways of protecting pedestrians and bicyclists in proximity to buses. It might make sense for FTA to conduct a synthesis of the technologies that are available for possible applications (if they haven't done so already). I think this topic is also ripe for UTC projects. Let the universities turn loose their young and creative technology students to develop innovative ways of minimizing such crashes.

10. *What is the FTA doing to focus public entities on embracing pedestrian detection/collision avoidance safety technology?*

    I am aware of some effort on the part of FTA to work with the transit industry in raising awareness of such technologies (as noted above, the demonstration in Portland). FTA has been given safety authority for transit operations, and the USDOT has launched an initiative on safe people, safe streets that is going to be finalized in the near future. It seems to me that Congress can let FTA know their interest in this issue so that any safety research that is conducted by FTA or through the TCRP program at the TRB should reflect this issue. As noted above with respect to UTC projects, this topic is also an ideal topic for the IDEAS program, in which entrepreneurs and innovators are asked to develop approaches to "solve" particular problems.

11. *Has the cost of self- insurance by public transit agencies been looked at as part of the calculus regarding technology implementation? Has the insurance industry been engaged to become involved regarding pedestrian detection/collision avoidance safety technology around large vehicles?*

    A few states have expressed interest in this topic as a possible research project, but to my knowledge not much has been done in considered self-insurance costs as part of the benefit/cost calculus for new technology implementation. I am not aware of any effort

where the insurance companies have been engaged on the issue of pedestrian detection/collision avoidance technologies.

12. *Have temporary work zones been taken into consideration when deploying V2X?*

    Work zones are an important "obstacle" for vehicle operations, even when under driver control. Traversing a work zone as an autonomous vehicle is even more challenging. I am aware of work that has been done looking at work zone characteristics to see how such information could be conveyed to other vehicles and how infrastructure monitors and sensors could be used to provide information on work zone traffic to vehicles.

13. *Do you have any suggestions or thoughts on what else Congress can do to create more efficient federal transportation research programs? How can we get more bang for the buck when it comes to transportation research? What can we do so that our transit agencies reap greater benefits from cutting edge research?*

    My most important suggestion is to provide more focus to the research programs on those issues of greatest importance to the nation, and importantly that service as the lynchpins for enabling great strides in technology advancement. We have a tendency to announce fairly general research initiatives....we want to improve safety, we want to enhance productivity, etc. Then, researchers are allowed to define their project statements within these broad categories. A better approach in my opinion is to identify key enabling research topics, that is, those that will lead to further advancements and improvements once the fundamental foundation has been established. In other words, target your resources on those topics that will clearly have a huge impact on the industry. We did this in the university environment when I was a professor. We would spend time thinking about what technologies or processes will likely lead to a domino effect of further technology advancements. So, for example, years ago we identified composite materials, "smart" sensors and environmental remediation has focus areas for research because we believed that each led to many further research and technology applications.

    Congress could ask for a research strategic plan and road map, focusing on the key technology and societal issues that the federal government has a role in, and a timetable for implementing the plan. The research programs of the USDOT should go through a self-assessment periodically to determine their overall effectiveness and a report to Congress should be prepared. I am aware that FHWA is doing something like this by identifying performance metrics associated with its research efforts.

14. *Would FTA's research benefit from more industry guidance and engagement? How can industry engagement be restructured or improved to increase technology adoption from FTA's research?*

    I am a strong believer in engaging those who are producing technology or who will be using technology in strategic planning and program development. The TRB cooperative research programs are an excellent example of such engagement, and the benefits

thereof. With respect to adoption of new technology, I have always thought that the best strategy was to have one's peers show and convince you that a particular approach or strategy was the best thing to do. The way to do this is through technology demonstrations similar to what was done decades ago in the (then) UMTA Service and Methods Demonstration Program. One of the advantages of the TCRP program is that transit industry representatives are on project panels and thus they can attest to the potential benefits a particular project could have to the industry. I do not believe a large industry advisory committee or steering committee offers any better way to foster innovation.

HOUSE COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY
SUBCOMMITTEE ON RESEARCH AND TECHNOLOGY

"U.S. Surface Transportation: Technology Driving the Future"

Questions for the record, Dr. Michael Meyer, Chairman, Research and Technology Coordinating Committee, National Academies' Transportation Research Board

Questions submitted by Rep. Elizabeth Esty, Member, Research and Technology Subcommittee

1. *What should be the federal role and timeline in standardizing connected vehicle infrastructure?*

   The analogy I like to use for standardizing connected vehicle infrastructure was the federal requirement in ISTEA for states and MPOs to develop an ITS architecture that would provide a consistent and compatible technology platform for future ITS applications. The federal government did not dictate what the applications should be or the technologies that should be deployed, but required that the characteristics of such applications be transferable to other locations. The question of connected vehicle infrastructure and the associated timeline is a difficult one for a variety of reasons. The first is the extent of the U.S. highway system. Much of the work that has been done on connected infrastructure has focused on the higher functionally classified roads, such as interstates and major arterials. Not much has been done on other roads, which is a problem because these other roads are a necessary part of the trip....one has to travel on local roads to get to the bigger roads. Thus, unless a technology for vehicle to infrastructure connectivity can be applied at a regional level, the level of investment and time needed to convert the system to such an operation will be very large.

   In addition, I am been in the profession long enough to hear and see claims about how a particular technology or application is going to revolutionize the transportation system in a very short period of time....only for it to take much longer. So with this as a caveat, I would suggest that the federal role in standardizing connected vehicle infrastructure should follow the timeline below:

   2015-2020: Funding of pilot demonstrations/applications; sponsorship of public/private conversations/discussions on likely future scenarios

   2018-2020: Required revisions to ITS system architecture and Concept of Operations Plans to include compatible V2I technologies and infrastructure.

   2020-2025: Funding for national transportation corridors to put in place needed infrastructure changes; federally sponsored evaluation studies on lessons learned.

   2025-2035: Funding for conversions in other major transportation corridors.

   2035 and beyond: Funding flexibility given to states to incorporate V2I into on-going transportation plans, TIPs, and project development.

HOUSE COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY
SUBCOMMITTEE ON RESEARCH AND TECHNOLOGY

"U.S. Surface Transportation: Technology Driving the Future"

Questions for the record, Dr. Michael Meyer, Chairman, Research and Technology Coordinating Committee, National Academies' Transportation Research Board

Questions submitted by Rep. Paul Tonko, Member, Research and Technology Subcommittee

1. *Can I expand on my vision for the federal government in helping to provide research and guidance for state and local transportation agencies?*

   Every state DOT has a research program that primarily focuses on issues of concern to their program and operations. Most local transportation agencies do not have the resources to have such a research program. It makes no sense for the federal government to fund research that the states are already funding. There is a national purpose for the making sure the results of state-funded research are indeed shared with other states so that benefits can occur across as many agencies as possible. This can be done by AASHTO , APTA or AMPO/NARC for their respective organization. However, there are national issues/topics/concerns that deserve attention from the federal government that no individual state or group of states will likely fund. Such issues as emerging fuels, compatible technology infrastructures, characteristics of national funding for a federal transportation program, relationship between transportation investment and national goals of air quality, economic development, etc. are not likely to receive as much attention from state and local officials. There is thus a need for a federal presence in examining the research and technology development aspects of what are truly national issues. However, I strongly believe there is a federal role in providing a national vision and/or road map on how all of the research components fit together. For example, much has been said about the V2V revolution we are about the experience with vehicle technologies. It seems likely that the V2I component of an overall technology strategy will be an important element of this future. The U.S. DOT can provide guidance on what such a strategy should be and what roles each participant has in this strategy. The federal government can provide a clearinghouse function to make sure that states and local governments do not repeat what has been accomplished by others. The federal government can investigate what other countries are doing with technology and research to see what can be applied in the U.S., or what could be jointly undertaken for mutual benefit.

2. *Do you believe there must be more regional collaboration in pilot and demonstration programs for newly developed V2I technology?*

   I do not see how we can apply consistent and transferable V2I technologies without regional collaboration and pilot demonstrations. The analogy is the federal requirement for states and MPOs to develop an ITS architecture that was consistent with other technologies that were going to be used in applying ITS strategies to the transportation

system. Although states and MPOs might have different types of applications (e.g., some might focus on incident response while others focus on mobility), there is a national interest in making sure that a traveler can go from one part of the country to the other and have compatible technology and information exchange where V2I capability is necessary. I saw many years ago in the then UMTA Service and Methods Demonstration Program the value of piloting different approaches and strategies for improving the transit system. These were invaluable experiences in that other transit agencies could see what was actually done and their results. I still believe that the best strategy in fostering innovation is showing other agencies and individuals where a particular approach has worked elsewhere. I would strongly recommend that such a nationally coordinated program be part of our strategy for evolving to a V2V and V2I concept.

Responses by Dr. Brian Smith

HOUSE COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY
SUBCOMMITTEE ON RESEARCH AND TECHNOLOGY

"U.S. Surface Transportation: Technology Driving the Future"

Questions for the record, Dr. Brian Smith, Director, Center for Transportation Studies, University of Virginia

Questions submitted by Rep. Barbara Comstock, Chairwoman, Research and Technology Subcommittee

1. In your opinion, does the Office of the Assistant Secretary for Research and Technology effectively fulfill its mission and responsibilities? In what specific ways might the office be improved?

   As the lead university in the Mid-Atlantic Transportation Sustainability (MATS) UTC, the University of Virginia (UVA), through our Center for Transportation Studies (CTS) has worked closely with the Office of the Assistant Secretary for Research and Technology. This has been our first opportunity to do so, and we have been very impressed with the organization and staff. We received clear and thorough feedback on the center plan we presented in our proposal. UTC requirements have been communicated well, and we have received prompt responses when we contact the office with questions. In our opinion, the office has achieved a healthy balance between necessary program oversight and center evaluation, and allowing UTC member universities the freedom to pursue programs with sufficient autonomy to take the risks necessary to conduct transformational research.

2. Is the current University Transportation Center (UTC) system overly focused on applied research in order to meet the needs of states instead of long-term national goals to create transformational technologies? What recommendations do you have to enable UTCs to conduct research that provides the most benefits to the nation?

   UVA CTS has found that the UTC has provided our researchers with the opportunity to pursue projects that go beyond the applied topics that we normally have the opportunity to address through state, local, and industrial funding. This is the true strength of the UTC program – it does provide university researchers the opportunity to explore basic, transformational research needed to meet the challenges of transportation in the decades to come.

3. How do states such as Virginia view long-term research and development?

   a. Do they see a need for it?

From our experience, states do see a clear need for long-term research and development. However, they generally see supporting this class of research and development to be a federal role. Given the tremendous transportation infrastructure needs, states are under enormous pressure to devote as much of their resources as possible to the operation, maintenance, and enhancement to the system. They typically seek to support shorter-term, applied research that leads to costs savings or increased performance, and that can be implemented quickly.

b. Where does it fit on the list of priorities?

Our experience at UVA CTS has been that long-term, basic research and development is typically a relatively low priority in state-funded transportation research programs.

c. Can you provide an estimate for the percentage of state transportation funds that are spent on research and development programs?

This is typically a relatively low percentage. For example, in FY10, the Virginia Department of Transportation (VDOT) devoted $14.3 million of its budget to research, out of a total budget of $3.79 billion. It is important to remember, however, much of the general budget is devoted to the large quantities of materials necessary to build and maintain transportation facilities. In addition, VDOT is considered to be one of the leading states in the area of transportation research and development. This clearly illustrates the critical role that federal support for transportation research and development plays in preparing the nation to address the transportation challenges of today and the future.

HOUSE COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY
SUBCOMMITTEE ON RESEARCH AND TECHNOLOGY

"U.S. Surface Transportation: Technology Driving the Future"

Questions for the record, Dr. Brian Smith, Director, Center for Transportation Studies, University of Virginia

Questions submitted by Rep. Dan Lipinski, Ranking Member, Research and Technology Subcommittee

1. Pedestrians, bicyclists, and other non-occupants make up an increasing share of traffic fatalities. How will advancing technologies like Vehicle-to-Vehicle and automated vehicle technologies benefit users outside of cars? What role should ITS JPO, NHTSA, and other federal agencies play in ensuring that all people benefit from these systems?

   Connected and automated vehicle technologies have the potential to provide significant safety benefits to pedestrians and cyclists. One of the key contributions of these technologies lies in improving situational awareness of drivers. For example, active collision avoidance systems rely on the "here I am" or basic safety message of the connected vehicle system to alert drivers to potential collisions. This is of particular significance when driver visual assessment of the situation is difficult (for example, consider vehicle blind-spots). The ability of pedestrians and cyclists to transmit similar "here I am" messages would be extremely beneficial.

2. Will non-occupants be able to benefit from connected infrastructure through mobile apps? Is there a role for the federal government to ensure that everyone, including low income and disable populations, can interact with these technologies?

   The ability of travelers to be "part" of the connected vehicle system beyond embedded equipment installed by automobile manufacturers will be critical. It is widely believed that utilizing existing mobile devices (such as Smartphones) will best support this. Continued federal leadership will be essential to ensure that the system evolves in such a manner.

3. As connected vehicle infrastructure is deployed, how can we ensure that deployment addresses safety concerns? What is the appropriate balance between safety and congestion concerns?

   The current connected vehicle program has a very strong focus on safety. At this point, the balance seems to be more skewed towards safety applications than congestion applications. While automobile manufacturers have focused almost exclusively on safety applications, federal involvement in the program has "kept" a level of focus on congestion applications. Federal involvement is essential in order for this to continue.

The remainder of Rep. Lipinski's questions appear to have been developed specifically for other individuals testifying at the June 12, 2015 hearing.

HOUSE COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY
SUBCOMMITTEE ON RESEARCH AND TECHNOLOGY

"U.S. Surface Transportation: Technology Driving the Future"

Questions for the record, Dr. Brian Smith, Director, Center for Transportation Studies, University of Virginia

Questions submitted by Rep. Paul Tonko, Member, Research and Technology Subcommittee

1. We all know the budget challenges faced by municipalities. They have limited resources and may not be able to invest in smart infrastructure on their own – let alone conduct R&D. But I believe the benefits of V2I depend on numerous localities in a region implementing such technology in a coordinated fashion. University Transportation Centers (UTCs) work with state and local transportation agencies regularly. Do you think UTC's could be an effective trainer and convener for regional V2I integration?

   Based on my experience in connected vehicles research and development, I agree that the benefits of the technology are dependent on system level deployment of infrastructure. Connected vehicles will be of limited effectiveness if a handful of disconnected states and localities implement.

   UVA CTS is a member of the Connected Vehicle/Infrastructure University Transportation Center (CVI-UTC), along with Morgan State University and Virginia Tech (the lead institution). This UTC has focused squarely on working with state and local agencies to develop, demonstrate, and test infrastructure-oriented connected vehicle applications. A key goal of this work is to show the benefits that connected vehicles will bring to infrastructure providers – in order to help provide the motivation necessary for their involvement and investment in the future. This work has led to a connected vehicle testbed operating in the Northern Virginia region – spearheaded by significant VDOT involvement and investment. Based on our involvement in this UTC, I do agree that the UTC program does provide a good mechanism to help achieve the goal of regional connected vehicle deployment. However, current regional UTCs cannot accomplish this task alone given their budget constraints and broad missions. To adequately support national deployment of a connected vehicles system would require a new "class" of regional centers with a mission focused on connected vehicles.

Responses by Mr. Jeffrey J. Owens

Answers to Hearing Questions for the Record from
Jeffrey Owens, Chief Technology Officer and Executive Vice President, Delphi Automotive

June 12, 2015 Hearing: U.S. Surface Transportation: Technology Driving the Future

Questions submitted by Rep. Barbara Comstock, Chairwoman, Research and Technology Subcommittee

1. As referenced in your testimony, there is plenty of computing, sensor, radar and GPS technology to move autonomous cars seamlessly through ordinary traffic and travel. But how do these technologies match up to judgments made instantly and effortlessly by human beings? It has been suggested that the computing capacity required to make the kinds of decisions drivers make instantly in complex conditions is at least one order of magnitude greater than current. For instance, compared to humans, what is the state of technology for encountering a jaywalking pedestrian? What is the state of technology for assessing and sorting out the safest and most efficient path through a busy, wet street – without slowing to a crawl?

Answer:

The ability to gain input from multiple sensors allows our vehicle to outperform an unaided driver in recognizing and reacting to potential accidents such as jaywalking pedestrians. Human eyes are good but can't beat a combination of radar, vision and lidar-based sensors. Delphi incorporated an array of sensors on its automated vehicle to address these issues, including a combination of Delphi short- and long-range radars: 6 ESRs (Electronically Scanning Radars) and 4 SRRs (Short Range Radars); three different cameras for vision-based perception: an ADAS camera (MobilEye EPM3), a high-resolution color camera, and an infrared camera; fused system of 6 lidars that are integrated around the periphery of the vehicle; V2X (vehicle-to-vehicle and vehicle-to-infrastructure) and localization systems all in combination with intelligent software algorithms (Ottomatika). We use multiple sensing technologies for improved safety and performance. As radar, vision, and lidar-based sensors each have unique strengths and weaknesses, we fuse these sensors together -- which allows them to compensate for one another and provide an accurate picture of the driving environment.

With respect to the state of vehicle routing technology, several car companies currently provide routing assistance in their production vehicles, including Volvo's traffic jam assist.

2. What is the status of developing and deploying autonomous vehicle technologies nationwide, and how long do you estimate until we have significant numbers of driverless vehicles on the road? What do you see as the auto industry's biggest challenge to making automated driving a reality?

Answer:

A. Despite the success of our cross-country drive, significant challenges remain in moving fully automated driving from concept to reality and finally to commercialization. It is also difficult

to predict the timeline for regulatory activity and mass consumer adoption. Quickly advancing technologies and growing consumer demand could result in a driverless car becoming a reality within the next 10-15 years. Several automobile manufacturers have already announced autonomous vehicle launches for as early as 2020 and Delphi is helping lead the way. Volvo and others began offering automated functions like collision mitigation braking and traffic jam assist in 2014.

B. Technology, infrastructure capability, affordability, responsibility/liability, regulation, technology validation and testing are among the issues that will need to be addressed before automated driving can become a reality. Government and industry need to work together and research, develop and release performance standards, validate and approve technology, continue to create and introduce mature and reliable software, as well as reduce the cost of systems. Industry will also need to win-over consumers.

C. These near-term implementations of automated technology will offer a significant improvement in accident and fatality statistics far in advance of a fully automated, driverless vehicle.

3. **New electronic technologies are increasingly being incorporated into vehicles for safety, mobility, and environmental reasons, as well as to enhance the consumer driving experience. However, the increasing use of such technologies, along with the development of "connected" vehicle technologies raises privacy concerns in terms of how this information is stored, used, and accessed. What kinds of information would be collected and stored in autonomous and connected vehicles, and who might have access to such information?**

Answer:

Delphi collects a broad array of data associated with its automated vehicles from sensors on the car. Delphi, as the owner of the vehicle, uses that data to analyze the car's performance and make improvements. That data belongs to the vehicle's owner, in our case, Delphi. In the case of a production car, the data would belong to the purchaser of the vehicle.

In both California and Nevada, we are required to collect such data and file reports with the states. This regime is obviously designed for early testing of automated vehicles, not production vehicles that will be sold to the public.

4. **As we move toward a world where autonomous vehicles are the norm, how would you define the "operator" of the vehicle, and who would you hold liable in accidents? What other legal issues need to be considered relative to autonomous vehicle technologies?**

Answer:

Ultimately that is a question for the OEMs and regulators. Currently Delphi views the individual who is responsible for the car's operation – the individual sitting behind the wheel with the capacity to override the autonomous function – as the responsible operator.

An additional legal issue which is discussed above in answered number three is the question of who owns the vehicle's data.

5. One of the features of Google Doc is the ability to save and regenerate every edit made to a document by a user. A similar feature in vehicles would likely be extremely valuable for people or companies that want to access the complete travel history of an autonomous car and its passengers. Does such technology exist, or is it in the works? If so, how would the relevant privacy boundaries be established?

Answer:
As with the answer to question 3, we are capable of collecting a broad array of data associated with the vehicle from all sensors on the car-- from where the car went to how fast it was traveling to how all the sensors were performing. We, as the owner of the vehicle, use that data to analyze the car's performance and make improvements. Privacy is protected since, in our opinion, the vehicle owner owns the data and can make decisions about its utilization.

6. During a recent demonstration by Carnegie Mellon University of its prototype for a driverless car,[1] it was explained that a human still needs to take over in certain circumstances. A news article also reported that human passengers in test autonomous cars are sometimes prone to motion sickness. Is this true, and has research been conducted on how to keep human passengers engaged in driverless cars?

Answer:
Drivers and passengers in driverless vehicles should be no more prone to motion sickness than passengers in traditional vehicles.

With respect to driver engagement, there are two technology systems that we implemented in our automated vehicle to help address the issue.

A. Driver Monitoring: Delphi's automated driving platforms are equipped with state-of-the-art driver state sensing systems, which allow the vehicle to monitor the availability of the driver in situations where a takeover may be necessary. If the driver is found to be unavailable, the vehicle is capable of coming to a stop until it is safe to proceed.

B. Drive-by-wire system: The drive-by-wire system featured in Delphi's automated driving platforms is implemented in a manner that preserves the function of the production vehicle's steering and drivetrain. When manually operated, the vehicle drives exactly as a production vehicle would operate. When auto mode is engaged, the automated system uses the same vehicle input interfaces as a human driver, which allows passengers to directly see and feel how the vehicle is behaving. The automated driving system is completely separable from the stock system, which allows the driver to instantaneously assume full control of the vehicle at any time.

Answers to Hearing Questions for the Record from
Jeffrey Owens, Chief Technology Officer and Executive Vice President, Delphi Automotive

Questions submitted by Rep. Dan Lipinski, Ranking Member, Research and Technology Subcommittee

1. Pedestrians, bicyclists, and other non-occupants make up an increasing share of traffic fatalities. How will advancing technologies like Vehicle-to-Vehicle and automated vehicle technologies benefit users outside of cars? What role should ITS JPO, NHTSA or other federal agencies play in ensuring that all people benefit from these systems?

Answer:
Active safety technology such as radar and vision systems can both recognize and alert the driver or automatically brake when the driver is not capable of responding in a timely manner to in-road hazards including pedestrians, bicyclists and motorcyclists. Blind spot detection, collision warning and collision imminent breaking all protect not just the driver and car passengers, but individuals near the moving vehicle. V2V will also play an increasingly important role in adding additional information about the environment in which the car is traveling. In recognition of these broad benefits generated by the adoption of active safety, the pedestrian, bicycling and motorcycling communities have endorsed H.R. 2702, the Safety Through Informed Consumers (STICRS) Act. H.R. 2702 will increase consumer awareness of the advantages and availability of active safety technology by including these crash avoidance technologies in NHTSA's safety ratings that appear on the window sticker of every new car. Attached are letters of endorsement from these communities.

The single best action NHTSA could take to ensure that all people benefit from these technologies is to include active safety technology in its five star rating system for all new cars. Such an inclusion would drive consumer adoption of active safety and democratize its availability, as increased demand will increase its availability in "base" model packages for new vehicles.

2. Will non-occupants be able to benefit from connected infrastructure through mobile apps? Is there a role for the federal government to ensure that everyone, including low-income and disabled populations, can interact with these technologies?

Answer:
Delphi does not currently develop mobile apps. Delphi supports broad availability of these technologies. As stated above, adding active safety to NHTSA's five star rating system will help make these technologies available to a much broader cross section of the car-buying public.

3. As connected vehicle infrastructure is deployed, how can we ensure that deployment addresses safety concerns? What is the appropriate balance between safety and congestion concerns?

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Answer:
Delphi believes that the connected vehicle infrastructure (V2X) will be and should be optimized for safety. The single biggest benefit from V2X is the improvement in safety that comes with its roll-out. V2X will also improve efficiency by reducing congestion (including by reducing accidents) and increasing road capacity.

4. How far of a set back will be experienced to the effort to reduce fatalities, injuries, and traffic delays if the spectrum issue is not resolved in favor of our industry/auto industry/private drivers and their passengers and CDL?

Answer:
It is critical that the spectrum currently identified for V2V communication remains free from harmful interference. There has been discussion of using this spectrum for other forms of communication, including WiFi. V2V and V2I are safety-of-life communications. We cannot afford to have these communications interrupted by harmful interference. We encourage NHTSA to accelerate adoption of ADAS technologies / functions into its 5 star NCAP assessment system. The impact of any delay on the spectrum decision can be minimized by early adoption of ADAS.

5. Delphi is at the forefront of demonstrating the technology is available. V2V will be rolling out next year with GM. Self-Driving cars are testing out extremely well. So far, those two initiatives are running almost independently. And the spectrum for V2V is at risk. Do you believe autonomous driving can be made safer by the use of V2X technology, and as such should more work be done to bring the two streams of research together?

Answer:
Delphi already provides vision and radar systems that warn the driver of a potential accident risk around the vehicle or in its path. This may include another car drifting into the driver's lane or helping the driver maintain a safe distance from the car ahead. Delphi's V2V technology goes a step further by reading radio signals sent from cars that have already detected a traffic situation. This data is then sent to other cars in the vicinity to warn their drivers and provide detailed information about the situation, such as location and duration of a construction zone. Additionally, The efficacy and efficiency of automated driving can be improved by V2V but it is not dependent on V2V. V2V technology provides another sensor input into our system that we can use to improve the integrity of our sensor fusion system.

V2V and V2X more broadly will clearly help improve safety of autonomous vehicles. It is an important piece of the autonomous driving equation. It is one element of a larger safety portfolio which includes a wide array of active safety and other technologies which can act both independently of V2X technology and in concert with it. Delphi believes that research underpinning the safety of driverless vehicles is important and should be prioritized, including active safety technology that relies on V2X as well as active safety technology that does not require V2X connectivity. Additionally, the benefits of V2V and V2I can be accelerated through aftermarket implementation of this technology on the current car parc, which mitigates the "grow in" period associated with drivers' transition to newer vehicles equipped with the latest safety features.

6. Would you be able to address the future of federal highway funding by means of automated tolling or Vehicle Miles Traveled charge calculations?

Answer:

Delphi does not have a position on automated tolling or vehicle miles traveled.

7. Very effective and relatively inexpensive collision avoidance technologies are available today for virtually all vehicles currently on the road as an after-market product that can be professionally installed (installation is not always by a dealer), or as a pre-installed feature by the car manufacturers. The after-market devices can provide critical advance warnings to drivers, and the pre-installed technology can even automatically apply the brakes when necessary. This technology is readily available from several companies and it can provide warnings to prevent collisions with pedestrians, other vehicles, bike riders, and joggers. In addition, the technology can loudly alert drivers that they are drifting out of their lane, over the center line or the markings at the edge of a road. Several recent truck collisions were caused by trucks unintentionally veering across center lines. As you know, the National Transportation Safety Board (NTSB) outlined the life-saving benefits of currently available collision avoidance systems in a recent report, and recommended that the technology become standard on all new passenger and commercial vehicles. NTSB's Special Investigation Report, The Use of Forward Collision Avoidance Systems to Prevent and Mitigate Rear-End Crashes, stresses that collision avoidance systems can prevent or lessen the severity of rear-end crashes, thus saving lives and reducing injuries. The report notes that a lack of incentives and limited public awareness has stunted the wide adoption of collision avoidance technology. How can DOT further accelerate deployment of life saving active safety features like these?

Answer:
Delphi believes that the NHTSA NCAP system should be more aggressive in adopting active safety or Advanced Drive Assistance Systems (ADAS) as part of their 5 star ratings. NHTSA has fallen behind other rating organizations, including (1) the European Union's counterpart rating

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EURO NCAP, which requires active safety features for a car to receive 5-stars and (2) the Insurance Institute for Highway Safety (IIHS), which includes active safety in its *Top Safety Pick+* (TSP+) rating.

Incorporating active safety technologies into the 5-star rating will drive consumer demand for these technologies. Speeding market adoption of these technologies as standard equipment in the US fleet could reduce automobile crashes by 31% and fatalities by 11,000 a year.

NHTSA currently recognizes the benefit of active safety technologies, recommending the use of these technologies on its website; however, information about these technologies is not included in the 5-star safety rating that appears on the window sticker of every new car. It is the 5-star rating system that drives consumer demand. Safety conscious consumers want to buy cars that are highly rated. The lack of inclusion of these technologies in the US government's rating system is dampening demand and giving consumers a false picture of which cars are the safest to own.

As a response, H.R. 2702, the Safety Through Informed Consumers (STICRS) Act, was introduced by Congressmen Todd Rokita and Earl Blumenauer. The bill will increase consumer awareness of the advantages and availability of active safety technology by including these crash avoidance technologies in NHTSA's safety ratings that appear on the window sticker of every new car. Passage of this legislation will help push DOT to accelerate the consumer demand, and therefore the deployment, of active safety technology.

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8. The recent Governors Highway Safety Association report from February 26, highlighted that pedestrian fatalities remained high in 2014. There is a constant stream of stories in the press about buses hitting pedestrians and bicycle riders; or collisions with other vehicles. A few months ago a 15-yr-old girl was hit and pinned underneath a New York City bus. Many collisions involve bus drivers making turns in crowded cities and simply not seeing every jogger, bike rider, or pedestrian at each busy intersection. I think that every parent's nightmare is an accident involving a school bus. Interstate and local bus traffic is increasing greatly and the risks of crashes caused by buses or caused by others hitting buses has to be addressed. As you know there are very effective and relatively inexpensive blind spot collision avoidance technologies available that can be retrofit on any bus or other large vehicle. Studies show that for long vehicles the blind spot is far larger along the side of the vehicle than most pedestrians believe. This technology is readily available from several companies and it can provide warnings to drivers to prevent collisions with pedestrians, other vehicles, bike riders, and joggers. In addition, the technology can loudly alert drivers if they are drifting out of their lane, over the center line, or the markings at the edge of a road. In addition, the alerts can also be heard by pedestrians and cyclists outside the vehicle as well, providing another layer of protection. Such solutions have also proven to substantially reduce fuel consumption costs, due to the positive conditioning effect they have on the habits of drivers. Studies show reductions in fuel use of 8% percent. What can DOT do to promote and accelerate adoption of these important technologies?

Answer:
We believe that DOT should require all buses be equipped with Blind Spot Warning (BSW) technology. The single best action DOT could take, however, to ensure that all people benefit from these technologies is to include active safety technology in its five star rating system for all new cars. Such an inclusion would drive consumer adoption of active safety and democratize its availability, as increased demand will increase its availability in "base" model packages for new vehicles.

Congress, likewise, can help reduce accidents and save lives by passing H.R. 2702, the Safety Through Informed Consumers (STICRS) Act.

9. There is so much publicity about the seemingly daily incidents-collisions between large vehicles and pedestrians/cyclists. However, the process of evaluating and implementing pedestrian detection/collision avoidance technology for pedestrian/cyclist safety as well as other safety measures in the public transit world is fraught with hurdles. Funds should be more readily allocated, first for evaluation and finally for implementation upon acceptance. What is the FTA doing to focus public entities on embracing pedestrian detection/collision avoidance safety technology?

Answer:
I believe the FTA can best address this question.

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10. Many public transit entities are either completely self-insured or self-insured up to a certain cap. Has this cost been looked at as part of the calculus regarding technology implementation? Has the insurance industry been engaged to become involved regarding pedestrian detection/collision avoidance safety technology around large vehicles?

Answer:
I am not familiar with the current state of discussions between the insurance industry public transit entities.

11. Have temporary work zones been taken into consideration when deploying V2X? For instance, it's one thing to be able to have the vehicle interact with fixed roadside hardware, but it's another issue for work zones which might only be in the road for a short duration.

Answer:
Yes. Delphi's active safety technologies do not just rely on preordained notions of how the road will be configured when the car arrives. The technology in Delphi's automated car sees and can react to real world conditions.

Delphi implemented an array of sensors on its autonomous vehicle to address these issues. Including a combination of Delphi short- and long-range radars: 6 ESRs (Electronically Scanning Radars) and 4 SRRs (Short Range Radars); three different cameras for vision-based perception: an ADAS camera (MobilEye EPM3), a high-resolution color camera, and an infrared camera; fused system of 6 lidars that are integrated around the periphery of the vehicle; V2X and localization systems all in combination with intelligent software algorithms (Ottomatika). We use multiple sensing technologies for better safety and performance. Because radar, vision, and lidar-based sensors each have unique strengths and weaknesses; we fuse these sensors together which allows them to compensate for one another and provide an accurate picture of the driving environment.

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12. The American people, the public transportation industry, and Congress all desire more efficient use of federal funds in the form of innovative construction methods such as P3's and the development of asset management practices. However, we have seen a steady and sharp reduction of research and development funds available through the TCRP in recent years which has negative impacts on innovative research efforts. Our national national transportation policy goals involve things such as i.e. more carbon friendly modes of transport, improved safety for transit, and improved cost efficiencies. If we want to achieve these goals, the trend of declining TCRP investment must be reversed. In addition to increasing program investments, do you have any suggestions or thoughts on what else Congress can do to create more efficient federal transportation research programs? How can we get more bang for our buck when it comes to transportation research? What can we do so that our transit agencies reap greater benefits from cutting edge research?

Answer:

Technology, infrastructure capability, affordability, responsibility, regulation, technology validation and testing are issues that must be addressed before automated driving can become a reality. Government and industry need to work together and research, develop and release performance standards, validate and approve technology, continue to create and introduce mature and reliable software, reduce the cost of systems as well as seek and obtain the approval of consumers.

There are several key areas where the DOT / NHTSA can assist the industry:

- The first and most immediate is changing NHTSA's 5-star rating system to include active safety technology. This will have an almost immediate impact on consumer demand and adoption of these life-saving technologies.
- Development of uniform policies / regulations across the States vs. the current situation where each State is establishing its own automated driving regulations.
- Programs/funding to accelerate the development and deployment of active safety or Advanced Drive Assistance Systems (ADAS) which are foundational to Automated Driving and bring immediate safety related benefits.
- Harmonization of minimum infrastructure (lane markings; signage; etc.) standards across States.

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Questions submitted by Rep. Elizabeth Esty, Member, Research and Technology Subcommittee

1. **Can you give us a sense of how quickly we can expect intelligent transportation systems technologies to enter the market? Could we expect vehicle-to-vehicle or vehicle-to-infrastructure communications technologies to be in vehicles on the market in 5 years?**

Answer:
We expect that fully automated driving will likely occur in several phases. As I mentioned in my testimony, active safety technology is a critical part of the roll-out. Each phase addresses different aspects that relate to vehicle safety, starting with active safety technologies found in the market today. Following phases will include different levels of V2V and vehicle-to-infrastructure (V2I) communication to enhance safety, followed by advancing degrees of automated driving. V2V and V2I can extend the range of the radar and camera sensors today, allowing vehicles to share traffic and road information in real-time with each other and the network, further expanding the "cocoon of safety" around the vehicle. Looking even further down the road, these systems will enable highway platooning and fully automated driving.

With respect to V2V timing, last September Delphi announced that it will be the first to market with V2V and V2I. The development output of this system is highly flexible and can be packaged and partitioned in many different ways for other markets and customers. Global production is targeted for launch in 2016 for the North American market.

Appendix II

Additional Material for the Record

PREPARED STATEMENT SUBMITTED BY REPRESENATIVE ELIZABETH H. ESTY

Thank you, Chairman Comstock and Ranking Member Lipinski, for holding this hearing, and thank you to our witnesses for your time and for sharing your expertise today.

Transportation infrastructure has the potential to dramatically transform over the coming years due to advancements in modern technology. Technology in our cars alone, from vehicle-to-vehicle technology, to vehicle-to-infrastructure technology and autonomous vehicles could drastically alter the landscape of our roads. With safety and privacy concerns paramount, a greater federal investment is needed to ensure transportation technology is reliable and secure as it is increasingly integrated with our transportation network. Additional technological developments to our transportation infrastructure could decrease congestion, improve efficiency, expand economic growth, and make our roads safer.