SMART MOBILITY: IT'S A COMMUNITY ISSUE

FIELD HEARING

BEFORE THE

SUBCOMMITTEE ON RESEARCH AND TECHNOLOGY

OF THE

COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY

HOUSE OF REPRESENTATIVES

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C O N T E N T S

October 25, 2019

SMART MOBILITY: IT'S A COMMUNITY ISSUE

FRIDAY, OCTOBER 25, 2019

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

The Subcommittee met, pursuant to notice, at 10:01 a.m., at Livonia City Hall, 33000 Civic Center Drive, Livonia, Michigan, Hon. Haley Stevens [Chairwoman of the Subcommittee] presiding.

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

Smart Mobility: It's a Community Issue

Friday, October 25, 2019
10:00 a.m. – 12:00 p.m. EST
Livonia City Council Chambers
33000 Civic Center Drive
Livonia, Michigan

PURPOSE

On Friday, October 25, 2019, the Subcommittee on Research and Technology of the U.S. House of Representatives Committee on Science, Space, and Technology will hold a field hearing titled, *"Smart Mobility: It's a Community Issue."* The purpose of this hearing is to explore the use of smart technology to improve the ability of small cities and suburban communities to provide safe and efficient mobility solutions, to examine the research and development needs to ensure this technology is accessible to diverse communities, and to consider best practices for integration of community input and consideration of unique community needs, as well as collaboration between public, private, and academic stakeholders.

WITNESSES

- **The Honorable David Coulter,** Oakland County Executive
- **Mr. Mark Dowd**, Executive Director, Smart Cities Lab
- **Dr. Raj Rajkumar**, Director of Mobility21 and George Westinghouse Professor of Electrical and Computer Engineering, Carnegie Mellon University
- **Dr. Tierra Bills**, Assistant Professor, Civil and Environmental Engineering, College of Engineering, Wayne State University
- **Mr. Scott Averitt**, Technical Expert and Manager of Public/Private Partnerships, Robert Bosch LLC

OVERARCHING QUESTIONS

- What are the benefits of smart mobility solutions? How can technologies be developed and deployed to effectively serve the needs of diverse communities?
- To what extent are smart mobility solutions applicable to small cities and suburban communities? What are the current and long-term challenges to deployment of smart mobility solutions in such communities?

- What additional research and development is needed to advance smart mobility solutions, in particular in less densely populated areas, including areas without a history of public transit?
- What is the role of federal science agencies in supporting research and development in smart mobility? How can federal agencies best partner with State and local governments, researchers, citizen groups, and the private sector to advance smart mobility innovations and deployment?

Background

The 2016 President's Council of Advisors on Science and Technology report, "Technology and the Future of Cities," envisioned smart cities as providing "opportunities to improve people's lives both by modernizing key infrastructures (such as energy, water, or transportation) and by using information technology (often with open data) to enhance city operations and services." The report described several key smart cities technologies and concepts for improving transportation and mobility that could help achieve safety, efficiency, accessibility, and environmental objectives for how we move people and goods across the nation.

Smart mobility is not only about building advanced infrastructure; it is also a people-centric concept that seeks to address social aspects of transportation. These include equity issues for economically challenged communities and helping seniors age in place. For example, testing and deployment of seamless payment systems for access to different mobility options should also consider how people without banking accounts or credit cards (the "unbanked" and "underbanked") and without smartphones will access the system.

Demographic shifts, social trends, and technological advancements are leading communities, city transit agencies, and businesses towards Mobility as a Service (MaaS) using multimodal, on-demand services.[1] Transit agencies are exploring adding more mobility-on-demand (MOD) service to their traditional fixed-routes public transportation services.[2] The U.S. Department of Transportation (USDOT) describes MOD as "an innovative, user-focused approach which leverages emerging mobility services, integrated transit networks and operations, real-time data, connected travelers, and cooperative Intelligent Transportation Systems (ITS) to allow for a more traveler-centric transportation system-of-systems approach, providing improved mobility options to all travelers and users of the system in an efficient and safe manner."[3]

[1] National Academies of Sciences, Engineering, and Medicine Transportation Research Board, Transportation Research Circular Number E-C244, May 2019, "Mobility On Demand – A Smart, Sustainable, and Equitable Future."
[2] Id.
[3] https://www.its.dot.gov/factsheets/pdf/MobilityonDemand.pdf

MOD may include various modes such as "carsharing, bikesharing, carpooling/vanpooling, ridesourcing, scooter sharing, microtransit, shuttle services, public transportation, and other innovative and emerging transportation solutions."[4] In 2018, thirty-six percent of adults in the U.S. said they had used a ride-hailing service, double that of 2015.[5] Forty-five percent of urban residents and 40% of suburban residents report having used a ride-hailing app.[6] A number of communities and city transit agencies are partnering with rail-hailing services or transportation network companies (TNCs), such as Uber, Lyft and Via, to provide more mobility options for their communities. These microtransit options often offer on-demand, door-to-door shuttle service at a subsidized, flat rate through a smart phone app. These kinds of partnerships are relatively new, and the Transportation Research Board recently issued a "Partnership Playbook" for cities contemplating this approach. The Playbook is based on lessons learned by early adopters, and key findings show that the biggest barrier to these partnerships is TNCs' hesitancy to share data with transit agencies based on privacy, public records requests, and competition concerns.[7]

On a smaller scale, micromobility options, such as human-powered and electric bikes and scooters, also provide access to transit for people that live beyond bus or other transit stops or who want to take a different route than available on transit. In the U.S., people have taken 207 million bike share and shared mobility trips since 2010. Eighty-four million of those trips were taken in 2018, double the number of trips taken in 2017.[8] However, these options may be less viable in less densely populated areas such as suburban communities.

At the January 2019 USDOT and Transportation Research Board workshop, "Mobility on Demand – A Smart, Sustainable, and Equitable Future," participants identified a number of research and policy needs. Among them are infrastructure-related research for automation and public-transportation, shared automated vehicles (SAVs), rights-of-way management and pricing to optimize sustainability, and accessible and equitable outcomes.[9] Outstanding research for SAVs includes understanding the potential impacts of SAVs on land use; understanding the social and behavioral impacts of vehicle automation; continuing research on cellular and dedicated short-range communications opportunities, challenges, and best practices; methods for

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[4] National Academies of Sciences, Engineering, and Medicine Transportation Research Board, Transportation Research Circular Number E-C244, May 2019, "Mobility On Demand – A Smart, Sustainable, and Equitable Future."
[5] https://www.pewresearch.org/fact-tank/2019/01/04/more-americans-are-using-ride-hailing-apps/
[6] Id.
[7] National Academies of Sciences, Engineering, and Medicine 2019. *Partnerships Between Transit Agencies and Transportation Network Companies*. Washington, DC: The National Academies Press. https://doi.org/10.17226/25425
[8] National Association of City Transportation Officials - https://nacto.org/shared-micromobility-2018/.
[9] National Academies of Sciences, Engineering, and Medicine Transportation Research Board, Transportation Research Circular Number E-C244, May 2019, "Mobility On Demand – A Smart, Sustainable, and Equitable Future."

incorporating SAVs into land use and transportation modeling and long-range planning; and best practices to prepare public agencies for SAVs.[10]

Research Funded by the Department of Transportation

USDOT initiated its Smart City Challenge in December 2015 to incentivize mid-size cities to propose innovative solutions to create an integrated smart transportation system that would use data, applications, and technology to help people and goods move faster, cheaper, and more efficiently.[11] USDOT provided $40 million in federal funding and the cities leveraged an additional $500 million in public and private funding. Out of 78 applications, the winner of the Challenge was announced in 2016 as Columbus, Ohio. Columbus's proposal included an integrated plan that would use several enabling technologies including a connected transportation network, integrated data exchange, and electric vehicle infrastructure. The other finalists were Austin, Denver, Kansas City, Pittsburgh, Portland, and San Francisco.

Congress also considered the need to invest in smart mobility in the most recent highway bill. The 2015 *Fixing America's Surface Transportation* (FAST) *Act* authorizes $77.5 million in FY 2020 for 35 University Transportation Centers. Improving mobility of people and goods is the focus of two of the five national UTCs, two of the 10 regional UTCs, and 10 of the 20 Tier 1 UTCs.

The FAST Act also provides $60 million per year from the Federal Highway Administration's (FHWA) Technology and Innovation Deployment Program for USDOT to establish the new Advanced Transportation and Congestion Mitigation Deployment (ATCMTD) Program (23 U.S.C. 503(c)(4)). The program awards five to 10 grants per year to fund the deployment of technologies that will, among other purposes, collect, disseminate, and use real-time traffic, transit, parking, and other transportation-related information to improve mobility, reduce congestion, and provide for more efficient and accessible transportation.[12]

The Intelligent Transportation Systems Joint Program Office (ITS JPO) and Federal Transit Administration (FTA) lead the department's Mobility-on-Demand (MOD) Sandbox through the Public Transportation Innovation account (49 U.S.C. 5312). Under this program, FTA provides funding to transit agencies to carry out innovative pilots and demonstrations of integrated MOD solutions, explore partnerships, develop new business models, and to investigate new, enabling technical capabilities such as integrated payment systems, decision support, and incentives for traveler choices.

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[10] Id.

[11] U.S. Department of Transportation "Smart City Challenge: Lessons for Building Cities of the Future," https://www.transportation.gov/sites/dot.gov/files/docs/Smart%20City%20Challenge%20Lessons%20Learned.pdf.

[12] Fixing America's Surface Transportation Act [P.L. 114-94] Section 6004.

Research Funded the National Institute of Standards and Technology

The National Institute of Standards and Technology (NIST) Global City Teams Challenge is an initiative to help communities in the U.S. and around the world leverage networked technologies to better manage resources and improve quality of life.[13] NIST and its partners created the International Technical Working Group in Internet-of-Things-Enabled Smart City Framework (IES-City Framework) to reduce barriers to adoption of smart city solutions. Two key barriers are lack of interoperability between systems and multiple competing architectures from which to choose.

Research Funded by the National Science Foundation

US Ignite, a national effort that originated out of the Office of Science and Technology Policy (OSTP) and funded by the National Science Foundation (NFS), partnered with NIST in the GCTC initiative. In addition, US Ignite and ATIS are developing a secure and interoperable Smart Cities Data Exchange framework. One of the major barriers to adopting smart mobility solutions is access to data, such as real-time data and results of mobility-focused smart city pilots in other communities. The framework would create interoperable data management platforms, data exchanges, and data marketplaces for cities, states, local and federal governments, citizens and others.

NSF also maintains the Smart and Connected Communities program, which "supports integrative research that addresses fundamental technological and social science dimensions of smart and connected communities and pilots solutions together with communities".[14] This program operates across several directorates, including Computing and Information Science and Engineering, Education and Human Resources, and Social, Behavioral, and Economic Sciences.

[13] https://www.nist.gov/news-events/news/2014/08/nist-global-city-teams-challenge-create-smart-cities
[14] https://www.nsf.gov/funding/pgm_summ.jsp?pims_id=505364

Chairwoman STEVENS. This hearing will come to order. Without objection, the Chair is authorized to declare recess at any time.

Good morning. Welcome. It's truly significant to be here today in Livonia, Michigan. I am delighted to host today's hearing and extend my warmest welcome and thank you to my esteemed colleagues, Congressman Bill Foster of Illinois and Congressman Michael Cloud of Texas. We thank our Chairwoman Eddie Bernice Johnson and Ranking Member Jim Baird, who could not be with us here today for the hearing but are supportive partners of today's event.

We also recognize our recently departed colleague, Congressman Elijah Cummings of Maryland. Mr. Cummings was a known and calming presence in the halls of Congress. Reflecting on his legacy and his wishes for our Congress, Mr. Cummings would be doing exactly what we are doing here today: Figuring out ways to advance our country and to help his district.

He had a significant emphasis in our Congress, incredible talents, and a voice that spoke truth. As his body lay in state yesterday in the Capitol, my colleagues and I said goodbye to a man who worked up until his last living moments on this earth. May we all be so lucky to witness such service to others and love of the beautiful country we call home.

We are here today to examine the use of smart technology to improve the abilities of small cities and suburban communities to provide safe and efficient mobility solutions. Smart mobility: It's a community issue.

Michigan's 11th District has been on the forefront of these innovations, playing a key role with our industry leaders and best-in-class workforce, so it is only fitting that we gather here today to discuss how to make technology more effective through collaboration between public, private, and academic stakeholders.

These are some of the questions that compel the work of Congress: How to best use government to yield the best results for regional economies like ours. Recent developments in connected and autonomous vehicles, combined with increasing computing power and travel data, have enabled rapid advances in regional planning and mobility. Smart mobility technologies have already begun to shape how Americans move around and live. They are being used to reduce traffic congestion and cut emissions.

A 2019 study by Texas A&M University found that national gridlock costs our country $166 billion per year. The most recent highway bill, the *Fixing America's Surface Transportation Act*, the *FAST Act*, provides some funding for smart mobility, including $60 million per year for the new Advanced Transportation and Congestion Mitigation Deployment Program and support for several University Transportation Centers focused on improving the mobility of people and goods. While these investments are important, like most of our transportation and infrastructure investments, we must do much more to meet the scale of the challenge and opportunity.

Smart mobility technologies also have the potential to move us toward the goal of a society with zero traffic fatalities. The National Highway Traffic Safety Administration announced just this week that overall highway fatalities decreased by 2.4 percent in

2018, the second year of declines. However, nearly 40,000 people lost their lives on our roadways. The same report showed that pedestrian fatalities increased 3.4 percent and bicycle fatalities increased 6.3 percent.

Finally, these technologies have the potential to provide affordable and reliable transportation to basic services like health care and employment for those living with disabilities, older adults, and others who do not have access to individual transportation. We need to start having a broader conversation about how smart technology can be applied in all communities. What works within major city limits may not work in the suburbs or small towns in which mobility options are more limited. The solution involves working with our communities, including our city councils, township boards, and county commissions across America with their unique needs in mind. Research is essential to achieving this goal.

In addition to supporting near-term deployment and testing of new technologies, it is important to invest in long-term research that looks beyond the horizon of today's capabilities. When America becomes a leader in the equitable development of mobility solutions, we will yet again set the standards and norms the rest of the world will follow.

So welcome to this insightful dialog on the transformations and capabilities of the 21st century mobility technologies in the home of American transportation.

[The prepared statement of Chairwoman Stevens follows:]

Good morning. It is truly significant to be gathered here today in Livonia, Michigan. I'm delighted to host today's hearing and extend the warmest welcome and thank you to my esteemed colleagues, Congressman Bill Foster of Illinois and Congressman Michael Cloud of Texas.We thank our Chairwoman Eddie Bernice Johnson and Ranking Member Jim Baird who could not join us for the hearing but are supportive partners of this effort.We also recognize the recently departed Congressman Elijah Cummings of Maryland. Mr. Cummings was a known and calming presence in the halls of Congress. Reflecting on his legacy and his wishes for our Congress, Elijah would be doing exactly what we are doing here today - figuring out ways to advance his country and help his district.

He had a specific emphasis on our future, incredible talents, and voice that spoke truth. As his body lay in state yesterday in the Capitol, my colleagues and I said goodbye to a man who worked up until his last living moments on this earth.

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Michigan's 11th district has been on the forefront of these innovations, playing a key role with our industry leaders and best-in-class workforce, so it's only fitting that gather here today to discuss how this technology can be made more effective through collaboration between public, private, and academic stakeholders.

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like most of our transportation and infrastructure investments, we must do much more to meet the scale of the challenge.

Smart mobility technologies also have the potential to move us towards the goal of a society with zero traffic fatalities. The National Highway Traffic Safety Administration announced this week that overall highway fatalities decreased by 2.4% in 2018, the second year of declines. Which still means that nearly 40,000 people lost their lives on our roadways. The same report showed that pedestrian fatalities increased 3.4% and bicyclists fatalities increased 6.3 %.

Finally, these technologies have the potential to provide affordable and reliable transportation to basic services like healthcare and employment for those living with disabilities, older adults, and others who do not have access to individual transportation.

We need to start having a broader discussion about how smart technology can be applied in all communities. What works within major city limits may not work in the suburbs or in small towns in which mobility options are limited. This will involve working with our communities including city councils, township boards, and county commissions to develop mobility solutions with the unique needs of our communities in mind.

Research is essential to realizing this goal. In addition to supporting near term deployment and testing of new technologies, it is important to invest in long-term research that looks beyond the horizon of today's capabilities. When America becomes a leader in the equitable development of mobility solutions, we will yet again set the standards and norms the rest of the world will follow.

Welcome to this insightful dialogue on the transformations and capabilities of 21st century mobility technologies in the home of American transportation.

Chairwoman STEVENS. Before I recognize Mr. Cloud for his opening statement, I would like to present for the record a robust set of letters of support from Pratt Miller, Ford Motor Company, BASF, Toyoda Gosei, Rolls-Royce, Harman International, General Motors, ZF North America, and ITS. Thank you all so much.

And now the Chair recognizes Mr. Cloud for an opening statement.

Mr. CLOUD. Thank you, Chairwoman Stevens. I appreciate the invitation to be with you here today in Michigan's 11th District. I am excited to be here and look forward to the conversation today. Thank you, witnesses, for being here, and thank you all for caring about this issue and showing up. I'm looking forward to a very healthy conversation on an issue that's really important as we look forward.

All of us on this Committee are aware of the challenges our Nation is facing with our aging infrastructure. But as we look to address these issues and support and that we take time to look ahead and dream about the future that can be to ensure that our public policy skates to where the puck is going so to speak.

Fundamental research can drive innovation that yields better and safer commutes for our constituents. These technologies, like enhanced safety features in vehicles, smart infrastructure, and wireless communication between vehicles and infrastructure, have the potential to benefit folks from rural south Texas or the suburbs of Detroit. Smart mobility has the potential to increase safety and reduce congestion, and as we work, we must ensure that smart mobility technologies also advance a better quality of life for all communities.

Citizens in urban, suburban, and rural communities rely on our transportation infrastructure to go to work, to attend school, to keep medical appointments, run errands, and travel to recreational activities. According to the Texas A&M Transportation Institute, the rural transit system in Texas faces increasing demand from a growing population of older and disabled residents. These men and

women are impeded by long travel distances to medical care and social services. Texas Department of Transportation data shows that rural transit districts saw an increase of ridership from 2016 to 2017, providing about 5.4 million trips Statewide.

Individually, communities, especially rural ones, have a limited capacity and capability to develop and to deploy mobility advanced solutions. In Texas, to assist in addressing this challenge, the Texas Department of Transportation has created the Texas Innovation Alliance. This alliance is a network of local, regional, and State agencies and research institutions that develop a portfolio of advanced mobility projects across the State of Texas, where I'm from. This alliance provides a platform for cities and regions to leverage resources and expertise to address some of the State's most pressing mobility challenges.

Like the Alliance, I today, too, look forward to hearing from our witnesses about the research, development, and technology activities being conducted by research institutions and the private sector and applied at State and local governments. And as a representative of a diverse district with both large, small cities, and many rural communities, I also hope to hear from our witnesses about how your work can benefit both the metropolitan and rural areas and specifically how it can best assist these communities for planning and preparing for the future.

I want to thank you all for being here today again, and thank you all for being here. We look forward to just an awesome conversation. I yield back.

[The prepared statement of Mr. Cloud follows:]

Good morning Chairwoman Stevens. I'd like to thank you for convening today's hearing and for inviting me to visit Michigan's 11th District. It's great to be here.

I look forward to hearing from our witnesses this morning about how communities can, and are, using smart technologies to provide safe and efficient mobility solutions.

All of us on this Committee are aware of the challenges our nation is facing with aging infrastructure. To effectively address these challenges, we must support and maintain basic research to aid and inform our state and local governments as they make transportation investments.

Such fundamental research can also drive innovation that yields better and safer commutes for our constituents.

These technologies, like enhanced safety features in vehicles, smart infrastructure, and wireless communication between vehicles and infrastructure, benefit folks from rural south Texas or the suburbs of Detroit.

The promise of smart mobility is vast-it has the potential to increase safety and save lives, reduce congestion and pollution, and save taxpayers' money. However, we must ensure that smart mobility technologies also advance a better quality of life for all communities.

Citizens in urban, suburban, and rural communities use public transit to go to work or school, keep medical appointments, shop and run errands, and travel to recreational activities.

According to the Texas A&M Transportation Institute, the rural transit systems in Texas faces an increasing demand from a growing population of older and disabled residents impeded by long travel distances to medical care and social services. Texas Department of Transportation data shows that rural transit districts statewide saw an increase in ridership from 2016 to 2017, providing about 5.4 million trips.

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form for cities and regions to leverage resources and expertise to address some of the state's most pressing mobility challenges.

Like the Alliance, I look forward to hearing from our witnesses today about the research, development, and technology activities being conducted by federally sponsored research institutions and the private sector, and how these advances are being utilized by state and local governments.

As a representative of a primarily rural district, I also hope to hear from our witnesses about how your work can be beneficial to rural areas and how we can best assist these communities for planning and preparing for the future.

I would like to thank all our witnesses for coming today and sharing your thoughts on the future of smart mobility. Thank you and I yield back the balance of my time.

Chairwoman STEVENS. Thank you. Well, if there are Members who wish to submit additional opening statements, your statements will be added to the record at this point.

[The prepared statement of Chairwoman Johnson follows:]

I want to thank Chairwoman Stevens for organizing this important hearing. As a longtime Member of both the Science, Space, and Technology Committee and the Transportation and Infrastructure Committee, I have great interest in how technologies are being developed and deployed to improve mobility, mitigate congestion, and reduce the environmental impact of transportation.

I am from one of the nation's big cities, Dallas, that has been investing heavily in both public transit and so-called micro-transit options such as scooters and bike shares. Texas is known for our love of big cars and we are continuing to expand our roadways to accommodate increasing traffic. However, we also recognize that we must invest in more comprehensive and forwardlooking mobility solutions. According to U.S. Census Bureau data, the Dallas-Fort Worth metro area gained more new residents in 2018 than any other metro area. As economic opportunities continue to expand in Texas, this trend will likely continue. We must find new and innovative ways to move all of our city's residents around safely, efficiently, and quickly, taking into account the unique needs of different segments of our population. Moving goods around efficiently will also be important to maintaining our economic growth.

As cities like Dallas continue to experiment with new mobility solutions, we must build partnerships with other cities to share data and best practices. We must also look to our neighbors in less dense communities outside of our city limits to ensure connectivity and flow of people and goods between the cities and suburbs, and to help share lessons that may be applied across diverse communities.

The suburbs will face their own unique challenges. Most suburban communities have limited or no public transit options. In many suburban communities, the population is aging, and increasingly, those individuals want to age in place. We must develop and implement mobility solutions that ensure that people who can no longer drive themselves have safe and easy transportation to supermarkets, medical appointments, and other essential services. In many cases, these solutions will involve public-private partnerships, including with ride hail companies.

However, we must proceed with caution. Younger people may be perfectly comfortable using a smart phone to order a ride and jump in a car with a stranger behind the wheels. Older people may be less comfortable with both the technology and the idea of getting in an unfamiliar vehicle. Understanding these attitudes and receiving community input into the design of new mobility solutions will be essential.

Today's hearing brings together an important and diverse set of perspectives from the public sector, the private sector, and the research community. This is an important discussion and will not be the only hearing this Committee will hold on the future of smart cities and communities. I thank the panel for contributing their time and expertise to our Committee.

Chairwoman STEVENS. And at this time, I'd also like to introduce and recognize our incredible collection of witnesses who have joined us here today.

Our first witness is the Honorable David Coulter. Mr. Coulter currently serves as Oakland County's third County Executive. He previously represented southeastern Oakland County on the Board of Commissioners from 2002 to 2010. During the time on the board, he was a member of the Finance Committee, which oversaw Oak-

land County's balanced 3-year budget, and he also recently served as the Mayor of Ferndale. Mr. Coulter earned a bachelor's degree from Michigan State University and an executive education certificate from the John F. Kennedy School of Government at Harvard University.

Our next witness is Mr. Mark Dowd. Mr. Dowd is the Founder and Executive Director of Smart Cities Lab, a nonprofit that provides a venue for cities to share what works and partner with the innovation community to forge new solutions. He is also a visiting scholar at the University of California Berkeley. He previously served in several roles in the Obama Administration, including Senior Advisor in the White House Office of Management and Budget, Senior Advisor in the White House Council of Environmental Quality, and a member of President Obama's Hurricane Sandy Task Force as a senior member and also, let us not forget, as a senior member of the President's Auto Task Force. Mr. Dowd holds degrees from Rutgers College and Seton Hall University School of Law.

After Mr. Dowd is Dr. Raj Rajkumar. Dr. Rajkumar is the Director of the Metro21 Smart Cities Institute, the T-SET National USDOT (United States Department of Transportation) University Transportation Center for Safety, and Mobility21, a USDOT National University Transportation Center for Mobility. He is also the George Westinghouse Professor at Carnegie Mellon University's (CMU's) Department of Electrical and Computing Engineering. Dr. Rajkumar's work is primarily in cyber-physical systems such as autonomous driving and vehicle networks. His research interests include operating systems, wired/wireless networking protocols, model-based design tools, and power management. Dr. Rajkumar received his Ph.D. from Carnegie Mellon University.

Our next witness is Dr. Tierra Bills. Dr. Bills is an Assistant Professor in the Civil and Environmental Engineering Department at Wayne State University. Much of her research focuses on investigating the social impacts of transportation projects. She develops activity-based travel demand models to investigate individual and household-level transportation equity effects for the purpose of designing transportation systems that will provide more equitable returns to society. Dr. Bills holds a bachelor's degree in civil engineering technology from Florida A&M University and a master's and Ph.D. in civil and environmental engineering from the University of California Berkeley, although she is a hometown gal.

Our final witness is Mr. Scott Averitt. Mr. Averitt works in the Corporate Government Affairs Group for Bosch located here in southeastern Michigan, where he serves as a technical expert and manager focused on advanced R&D (research and development) projects, public-private partnerships, and government-funded projects. He collaborates across all four of Bosch's business sectors, including mobility solutions, industrial technology, consumer goods, and energy and building technology. Mr. Averitt holds a degree in electrical engineering from Lawrence Technological University right here in Southfield.

As our witnesses should know, you will each have 5 minutes for your spoken testimony. Your written testimony will be included in the record for this hearing. When you have completed your spoken

testimony, we will begin with questions, and each Member will have 5 minutes to question the panel.

And it should also be recognized that we have a robust audience in attendance here today representing the stakeholders in southeastern Michigan who are relying on these mobility solutions, working on these mobility solutions, and proliferating new technologies so that regions like ours will lead the world.

We will start with Mr. Coulter for a 5-minute testimony. Mr. Coulter?

TESTIMONY OF THE HON. DAVID COULTER,
OAKLAND COUNTY EXECUTIVE, OAKLAND COUNTY, MICHIGAN

Mr. COULTER. Thank you, and good morning to everyone and especially esteemed Members of the Subcommittee on Research and Technology. I'm honored to be here and grateful to Congresswoman Stevens and her colleagues for the invitation to testify on smart mobility.

As the Congresswoman said, I'm Dave Coulter. I'm the County Executive for Oakland County, Michigan, which is the home of Fiat Chrysler headquarters and Engineering Center, General Motors' Proving Ground, Nissan Research and Development Center, and hundreds of suppliers and other companies working on the development of smart mobility technologies.

Oakland County is also home to 1.25 million residents and 1.14 million registered vehicles. That's about 912 cars for every 1,000 residents, which far exceeds the national average. We like our cars. The Road Commission for Oakland County, which is a separate entity from the county, maintains the largest county road system in Michigan.

Now, in 1967 Oakland County had 6.8 deaths for every 100 million vehicle miles of travel. Fifty years later in 2017 that number was reduced to 0.53 deaths per 100 million vehicle miles traveled. It's a huge improvement over 5 decades, but we still have a way to go to prevent fatal and injury traffic crashes, the barriers to reduce if not outright eliminate traffic fatalities. Oakland County believes the solution lies in public-private partnerships that will enable cars to utilize smart mobility technology to talk to each other and the road infrastructure around them.

Today, I'd like to give you just a brief snapshot of how Oakland County is partnering with other governments, nonprofits, and private industry to advance smart mobility development. Our biggest project to date involves P3 Mobility, a Toronto, Ontario-based company, which was selected by Oakland County to develop a business plan for a connected vehicle infrastructure using smart mobility technology. The contract between Oakland County and P3 Mobility was signed on January 23 of this year. Our partnership with them is launching a pilot to use roadside units placed at intersections to test both smart mobility technology and multiple revenue-generating opportunities.

Advanced safety technologies provide consumers with improved vehicle innovations that save lives. We believe these new technologies can eliminate 94 percent of fatal crashes involving human error. If a successful business model can be developed, this will guide Oakland County in generating revenue to offset the cost of

the deployment of connected vehicle infrastructure to Oakland County's 1,600 signalized intersections and create a safer road system.

This pilot program has explored funding options with traditional infrastructure financing entities but has experienced resistance. We believe that resistance will continue until a State or Federal vehicle safety mandate is established and/or the industry further advances smart mobility technology to make it more cost-effective.

There are other smart mobility projects occurring around Oakland County. The Michigan Department of Transportation (MDOT) is utilizing its modernization of I–75 in Oakland County from 8 mile to M–59 to install smart mobility technology infrastructure so Congress can receive information about road conditions on the freeway, on weather and road conditions, backups, curve warnings ahead, and that sort of thing. It's worth noting that the auto companies will use this stretch of I–75 as a testbed for smart mobility technology.

Another MDOT smart mobility project that runs through Oakland County worthy of mention is roadside units, which will be placed up along Woodward Avenue from downtown Detroit to Pontiac. These roadside units will make drivers aware of real-time traffic information, will perform greenlight prioritization to move traffic through an intersection, and offer a safety message network which will alert drivers to traffic threats such as vehicles approaching an intersection at a high rate of speed.

Related smart mobility infrastructure projects by MDOT are also either underway or will be in the near future on major roads in Oakland County like Telegraph and M–59, I–696, and I–96, among others.

So, as you can see, smart mobility is of immeasurable value to Oakland County and its businesses and residents because it will improve traffic safety and quality of life and attract jobs by driving business development. Oakland County is proud to be on the leading edge of this development of smart technology and will continue to work with our public, private, and nonprofit partners to move smart mobility solutions forward. Thank you.

[The prepared statement of Mr. Coulter follows:]

Field Hearing: Smart Mobility: It's a Community Issue
Subcommittee on Research and Technology
U.S. Rep. Haley Stevens
Livonia City Hall, 33000 Civic Center Drive, Livonia
Friday, October 25, 2019 at 10 a.m.
David Coulter, Oakland County Executive

Testimony

Good morning, esteemed members of the Subcommittee on Research and Technology.

I am honored to be here and grateful to Congresswoman Stevens and her congressional colleagues for the invitation to testify today about Smart Mobility technology.

My name is David Coulter. I am the county executive for Oakland County, Michigan which is home to Fiat-Chrysler Headquarters and Engineering Center, General Motors Proving Grounds, Nissan Research and Development Center, and hundreds of suppliers and other companies working on the development of Smart Mobility technologies.

Oakland County is also home to 1.25 Million residents and 1.14 Million registered vehicles.

That's about 912 cars for every 1,000 residents which exceeds the average for the rest of the U.S.

The Road Commission for Oakland County, which is a separate entity from county government, maintains the largest county road system in Michigan with 1,800 traffic signals; 2,700 miles of county roads; and 90,000 road signs.

In 1967, Oakland County had 6.8 deaths for every 100 million vehicle miles of travel.

Fifty years later in 2017, that number was reduced to 0.53 deaths per 100 million vehicle miles traveled.

That's a huge improvement over five decades, but we still have a ways to go to prevent fatal and injury traffic crashes.

The goal is to reduce, if not outright eliminate, traffic fatalities.

Oakland County believes the solution lies in public-private partnerships that will enable cars to utilize Smart Mobility technology to talk to each other and the road infrastructure around them.

Today, I'd like to give you a snapshot of how Oakland County is partnering with other governments, non-profits, and private industry to advance Smart Mobility development.

Our biggest project to date involves P3 Mobility, a Toronto, Ontario-based company which was selected by Oakland County to develop a business plan for a connected vehicle infrastructure using Smart Mobility technology.

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Related Smart Mobility infrastructure projects by MDOT are also either underway or will be in the near future on major Oakland County roadways and freeways such as:

Telegraph Road, M-59, I-696, I-96, among others.

As you can see, Smart Mobility is of immeasurable value to Oakland County and its businesses and residents because it will improve traffic safety and quality of life and attract jobs by driving business development.

Oakland County is proud to be on the leading edge of the development of Smart Technology.

We will continue to work with our public, private, and non-profit partners to move Smart Mobility solutions forward.

David Coulter is honored to serve as Oakland County's third County Executive. At this important juncture for our County, his inclusive style seeks to leverage the strength of county government and tap the broad diversity of our residents to open a new doorway for future progress.

Dave brings a wealth of local government and executive experience. He represented Southeast Oakland County on the Board of Commissioners from 2002-2010 where he was well-respected by colleagues on both sides of the aisle. While on the board, he was a member of the Finance committee which oversaw Oakland County's balanced three-year budget and started an innovative program that provided health insurance to over 5,000 residents.

He brought that experience with him to his service as Mayor of Ferndale. At his first meeting, Dave directed City staff to begin implementing multi-year budgeting. He also formed the Mayor's Business Council in order to be more responsive to industrial and large businesses. During his tenure, Ferndale improved their credit rating twice, lowered city taxes, reduced the industrial vacancy rate, invested in local roads, parks and parking accessibility in their thriving downtown.

At the same time, Dave served as the Director of External Relations for the Children's Foundation of Michigan, formerly the Children's Hospital of Michigan Foundation. Here he was able to focus on public policy and local efforts to improve the health of children and families through our region and state. Under his leadership the Foundation invested in abuse and neglect, nutritional wellness and cancer research.

Dave also served as the Executive Director of the Michigan AIDS Fund which funded HIV prevention programs. Early in his career he was a Senior Public Affairs Officer for Michigan Consolidated Gas Company, a school teacher and a senior engineering draftsman.

Mr. Coulter was raised in St. Clair Shores, Michigan where he attended St. Joan of Arc School. He graduated from Bishop Gallagher High School in Harper Woods, Michigan. He then earned a bachelor's degree from Michigan State University and an Executive Education Certificate from the John F. Kennedy School of Government at Harvard University.

Chairwoman STEVENS. Thank you, Mr. Coulter.
Mr. Dowd, you now have 5 minutes.

TESTIMONY OF MR. MARK DOWD,

DIRECTOR, SMART CITIES LAB

Mr. DOWD. Thank you. Good morning, Chairwoman Stevens, Congressman Cloud, and Congressman Foster. My testimony will focus on how small towns and suburban communities can begin the journey of providing safe and efficient smart mobility solutions.

A little bit about the lab, Smart Cities Lab, it grew out of the work I did in the prior Administration. We set up the lab as a city-facing organization focusing on helping communities, cities, and regions to decipher and engage in innovative mobility solutions. The lab is comprised of 12 cities that have a wide range of population from under 100,000 people to over 4 million, different growth patterns from dense to suburban, and diverse political compositions.

Our mission is to find ways for cities and communities to collaborate with each other and to share what works and, more importantly, what doesn't work in the area of smart mobility and equity. It is true that smaller communities and cities often lack the expertise and capacity to engage in this space, but I believe it is only through collaboration with similarly situated communities that you'll be able to find the ability to engage in smart mobility.

I wanted to provide some of the best practices that we've found over the past 4 years in working with communities, and I think there are nine of them. I'll move through them quickly.

First is resist the pull of the shiny technology-driven solution. It's often very hard for communities not to go for the thing that looks good instead of going for the thing that they need.

Second and probably most important best practice is understanding and defining your community's needs and challenges as the first thing you do. It is often to rush toward the solution rather than focus on what it is—the problem, and then use the technology and innovation to try to solve that problem.

Collaborating and partnering with other local and regional universities: The ability to work with universities expands the capacities of local communities to be able to do and see much more of the opportunity that's out there.

Conduct deep community engagement. Understanding what your community needs rather than guessing what your community needs is a critical tool in being able to deploy smart mobility.

Developing regional and Statewide communities of practice: I think that this is an important piece, and I wanted to spend 2 seconds on this because Congressman Cloud mentioned the Texas Innovation Alliance. The lab works directly with the Texas Innovation Alliance to develop—we've developed four communities of practice. Those four communities of practice, we drive—the capacity piece I was talking about that many of the communities in Texas and many of the cities and communities that I work with don't have the ability to do the things that they need to do. They don't have the data scientists. They don't have experts like Raj. They don't have them at their fingertips. But cities like Pittsburgh work directly with CMU to work to try to get that done and then share

that knowledge with the other cities and the communities of practice.

Those communities of practice focus on four areas. The four areas that we focus on are: Seamless mobility, the ability to move seamlessly from one place to the other without having to get necessarily in your car. The second piece is real-time data. It's often very difficult for communities to both develop and then also ingest all that data so they work on that piece. Equity and access, it is often very difficult for people who are transit-dependent to be able to get to the places where they need to get to and being able to get people to work, and so we work on equity and access in that space. And last is energy and sustainability in trying to deal with the fact that transportation is the largest emitter of greenhouse gases in our country.

The sixth best practice is breaking down the silo barriers that I'm sure that even the County Executive would agree that even within your community that many people work in a vertical way rather than a cross-functional way, and once you start working cross-functionally, you can actually start breaking down some of those barriers.

Not all private sector companies make good partners. That's a very important piece to understand. Obviously Bosch I believe is one of those companies that is a good partner. I know that our experience in the lab that General Motors has been an excellent partner. And then there are other companies who are not very good partners. And it's very important for communities to understand the difference between those two things. And again, to the extent that the company is out there co-creating a solution with you as opposed to selling you something, that's the better road to go.

Preparing your workforce for an automated future, that's a really important piece that it's hard to do, and the capacity within southeast Michigan to be able to prepare your community for this with the companies that you have here would rely on their expertise and their ability to be able to help you make that transition.

Last one is making transportation affordable. It is really, really hard right now for communities that are car-dependent for the people who don't have cars, for the people that don't necessarily have access to those and they have to take an Uber or Lyft, it's $15, $20. It cost me $27 to get here, so affordable transportation in rural communities and in suburban situations is really important. Thank you very much. I appreciate the time.

[The prepared statement of Mr. Dowd follows:]

Testimony of Mark K. Dowd
Subcommittee on Research and Technology
October 25, 2019

Good morning Chairwoman Stevens and members of the Subcommittee on Research and Technology. My name is Mark Dowd and I am the Executive Director of Smart Cities Lab and a Visiting Scholar at University of California Berkeley. My testimony will focus on how small towns and suburban communities can begin the journey of providing safe and efficient smart mobility solutions.

First, it is important to understand that terms like smart mobility and smart cities are commercial terms that are not intended to exclude regions, suburban and rural communities, or counties. Instead the terms represent the convergence and strategic organization of innovation, digital technologies, and data for the purpose of advancing the goals of environmental sustainability, economic development, equity, efficient service delivery, and enhanced quality of life for individuals and society. Smart cities advance innovations in public policy and administration, which foster collaboration and partnerships focused on place-based and people-oriented solutions.

In the United States, the transport sector is the largest emitter of greenhouse gas (GHG) emissions. For this reason, smart cities and smart mobility are often closely related to GHG reduction strategies and low-carbon, land-use, and transportation policies. As such, it is not uncommon for smart mobility concepts to emphasize technology solutions. In recent years, the concept of smart cities has grown rapidly as communities are increasingly challenged to intelligently and efficiently use resources in support of innovation, government efficiency, and environmental sustainability. While precise definitions of "smart city" vary, smart cities frequently leverage innovation and the use of big data and innovative mobility strategies to manage an ecosystem of civic resources, including transportation systems; telecommunications; utilities; health and human services; public safety; and other community services.

As more fully set forth in my testimony below, I suggest some best practices for communities to work together to develop smart mobility options:

1. **Resisting the Gravitational Pull of Shiny Technology-Driven Solutions**. It is hard advice to follow but communities should resist moving too quickly to implement the attention-getting solutions that may work in other cities but may not be a good fit for your community.
2. **Understanding and Defining Your Communities' Needs and Challenges**. A critical first step is to develop consensus around the needs and challenges of your community and surrounding region, and then prioritizing those challenges. It far better to select, pilot, and then implement solutions when there is consensus in the community on the problem you are trying to solve.

3. **Collaborate and Partner with a Local or Regional University.** Universities and communities may speak very different languages, but your community can overcome its lack of expertise in various subject matters if it can find mutually beneficial ways to partner with your local or regional university. There are organizations like MetroLab Networks, and grant programs like the National Science Foundation's Smart and Connected Communities, that work to bring communities and universities together to solve challenges together.
4. **Conducting Deep Community Engagement.** It may be more difficult and more time consuming, but success is directly related to conducting deep community engagement prior to implementing expensive and complex solutions.
5. **Developing Regional or State-Wide Communities of Practice.** Often smaller communities and cities lack the expertise and capacity to engage in this space. It is only through collaboration that these communities, like Livonia, can start considering the efficacy of various mobility solutions to address your communities' needs. Peer-to-Peer collaboration and the public-sector stakeholder engagement process revealed that there is a lot of interest in collaboration, identification of case studies and best practices, and development of an implementation strategy to solve a variety of challenges. Allowing communities – through their public agencies -- to engage with each other in structured and non-structured environments, outside of the typical smart cities conference environment and not in the presence of private sector vendors, would result in the immediate benefit of being able to candidly share knowledge about what works and what does not with peers in other cities and public agencies.
6. **Breaking Down Silo Barriers.** Organizational and departmental barriers stifle innovation and create inefficiencies. Breaking down organizational silos is needed to foster innovation, knowledge, and collaboration with an array of community stakeholders including public agencies, non-profits, the private sector, and others. There is an increasing recognition of the need for partnerships, and a recognition that no one organization can do everything themselves.
7. **Not All Private Sector Companies Make Good Partners.** Many of the cities that I work with are inundated by salespeople with solutions seeking problems. It is better to work with the private sector to co-create solutions to the specific mobility challenges facing your community. For example, scooters may be great in Downtown Detroit, but they may not work in all parts of your community.
8. **Preparing the Workforce for an Automated Future.** There is a lot of concern that automation will displace jobs, and concern about the vast impact this will have on citizens and cities, including through impacts on employment and economic development. There is a desire for public agencies to proactively prepare for automation and leverage the

potential positive impacts. There is also a recognition of the need for workforce development and for ensuring that training and job placement keeps up with automation.

9. **Make Transportation Affordable.** Transportation is becoming less and less affordable for those who need it most. Not every family can afford $10-$20 Uber to and from the doctor. We are approaching perfect storm of changing transportation options as new technologies come on-line, transit agencies cutting service due to resource constraints, and the spatial mismatch of affordable housing and job centers. The consequence of this perfect storm is that transportation costs are becoming a larger percentage of household budgets and transit-dependent residents are faced with fewer options.

Smart City Challenge. These best practices are the direct result of my work with cities and communities over the past four years. I am proud of the fact I was the architect of U.S. Department of Transportation's (USDOT) Smart City Challenge, and that Secretary Foxx empowered me to lead a talented team at USDOT in executing the initiative from December 2015 to June 2016. The purpose of the Smart City Challenge was to increase cities' and communities' focus on the use of integrated data, technology, and innovation as tools for solving stubborn urban challenges related to mobility. Mid-sized cities were targeted for this competition as they were viewed as the cities with the greatest need of technology solutions to the challenges of aging infrastructure.

USDOT took a different approach to grant-making by awarding the entire $40 million to a single city (Columbus) rather than allocating this funding to multiple jurisdictions. The purpose of the challenge was to encourage cities to deploy these tools to plan for increased urbanization and growth that will put a significant strain on cities' capacity to deliver basic services. Paul Allen's Vulcan Inc. joined USDOT's Smart City Challenge by committing an additional $10 million to the winning city chosen through a USDOT selection process. The Smart City Challenge represents one of the first initiatives to advance understanding of smart cities and to recognizing how strategic partnerships among public sector agencies, institutions (e.g., community-based organizations, academia), and private sector technology providers can make cities more livable, efficient, environmentally sustainable, and equitable.

Eighty-one cities submitted 78 proposals for the USDOT's Smart City Challenge (a few cities were part of larger regional submissions). The 78 applicants faced a common set of urban mobility challenges and many proposed new approaches to solve these challenges. For example, 47 cities proposed projects to test the use of automated shuttles to connect travelers to their destinations. Atlanta proposed a network of multimodal transportation centers serving as hubs for mobility, economic development, and community activity. Two-thirds of the applicants proposed strategies to employ sensors and connected vehicles in order to collect data about

travel by vehicles, bicycles, and pedestrians. Many Smart City Challenge applicants incorporated into their proposals advanced transit systems, smart parking information systems to facilitate urban deliveries, and carsharing services enabled through traveler information systems, digital kiosks, and smartphone solutions.

Smart Cities Lab. Growing out of the success of the Smart City Challenge, we stood up the Smart Cities Lab (Lab) as a city-facing organization focusing on helping communities, cities, and regions decipher and engage in innovative mobility solutions. The Lab is comprised of 12 cities that have a wide range of populations (from under 100,000 people to 4,000,000 people), different growth patterns (dense to suburban), and diverse political compositions. As the founder and Executive Director of the Lab, my mission is to find ways for cities and communities to collaborate with each other to share what works, and what does not work, in the area of smart mobility and equity. It is true that smaller communities and cities often lack the expertise and capacity to engage in this space. It is only through collaboration that these communities, like Livonia, can start considering the efficacy of various mobility solutions to address your communities' needs.

Communities of Practice. Between 2017 and 2018, the Lab collaborated with our colleagues at the Texas Innovation Alliance (Alliance) to stand up four Communities of Practice (CoP) focused on smart mobility. The Alliance, who is focused on cities and regions in the State of Texas, and the Lab shared a common member (Austin) and we worked to integrate the cities from both organizations into a single collaborative network.

The concept of "Communities of Practice" (CoP), where a group of people share a craft or profession, was first proposed by cognitive anthropologist Jean Lave and educational theorist Etienne Wenger in 1991, who theorized that communities can evolve naturally around information sharing, as well as storytelling, because of common interest in a particular area, or around deliberately creating with the goal of gaining knowledge on a topic. The Alliance and the Lab learned from their cities and regions that their public agencies wanted an agency-only peer-to-peer network that would allow them to build a trusted space to share what works, and more importantly what does not work, with each other.

The CoPs focused on four smart mobility domains: Seamless Mobility; Real-Time Data; Energy and Sustainability; and Equity and Access. As part of the CoPs, the Lab and the Alliance: (1) sought input from the participating cities on content and programming; (2) established the effort as a city-led process (as opposed to a NGO-led process); (3) identified public agency co-chairs for each of the five CoPs; (4) built a governance structure for the multi-city network; and (5) established a steering committee to oversee the CoPs.

Each CoP typically meets once a month to discuss and share information including strategies and tactics for addressing the problem statements; what works and what needs improvement; best

practices; emerging issues and technologies; and updates on various initiatives. Since the April 2018 launch, the CoPs have yielded enthusiastic participation and a potent low-cost platform to share knowledge in real time and develop trust relationships among the cities. Today, the Lab and Alliance have over 265 people participating from 68 public agencies in 21 cities.

In conclusion, small cities and suburban communities can and should deploy smart technologies to improve their ability to provide safe and efficient mobility solutions provided they follow some best practices. These best practices are based upon my working directly with and for cities over the past four years.

Thank you, committee members and Chairwoman Stevens, for this opportunity to provide my testimony today.

Mark K. Dowd

Mark K. Dowd is the founder and Executive Director of Smart Cities Lab, a nonprofit that provides a venue for cities to share what works and partner with the innovation community to forge new solutions to their stubborn challenges. He is also a Visiting Scholar at University of California Berkeley where he is working with cities to find innovative ways to accelerate the adoption of new mobility technologies. Mark also serves on the Urban Air Mobility Strategic Advisory Group.

Prior to starting Smart Cities Lab, Mark served several different roles in the Obama Administration. He was a Senior Advisor in the White House Office of Management and Budget and a Senior Advisor in the White House Council of Environmental Quality. Mark also was a member of President Obama's Hurricane Sandy Task Force and served for three years as a senior member of the President's Auto Task Force, where he worked on the historic restructuring of General Motors and Chrysler.

Mark also served as a Senior Advisor to U.S. Department of Transportation's Secretary Foxx and a Deputy Assistant Secretary for Research and Technology where he worked on issues related to technology and innovation. Mark is the architect of the Smart City Challenge that fundamentally changed the way American cities approach mobility.

He received the U.S. Environmental Protection Agency's Gold Medal as well as awards from the Department of Justice's Environment and Natural Resources Division, the U.S. Attorney's Office (Southern District) for his work on the GM and Chrysler bankruptcies, and the U.S. Department of Transportation for creating and executing the Smart City Challenge.

Mark's nongovernmental service includes the Director and Assistant General Counsel at the Association of Global Automakers where he worked on policy development for advanced vehicle technologies. Mark practiced law for thirteen years in New York City at the law firm of Schulte Roth & Zabel, specializing in transactions, restructuring, litigation, and regulatory matters as they relate to environmental and energy issues. Mark attended Rutgers College and Seton Hall University School of Law.

Chairwoman STEVENS. Dr. Rajkumar, you now have 5 minutes.

**TESTIMONY OF DR. RAJ RAJKUMAR,
DIRECTOR, MOBILITY21, AND GEORGE WESTINGHOUSE
PROFESSOR OF ELECTRICAL AND COMPUTER ENGINEERING,
CARNEGIE MELLON UNIVERSITY**

Dr. RAJKUMAR. Good morning, Chairwoman Stevens, Congressman Foster, and Congressman Cloud. Thank you for this opportunity for me to testify before this important hearing today. I am Raj Rajkumar from Carnegie Mellon University in Pittsburgh, Pennsylvania.

I want to thank this Committee for its interest in smart cities technology. My academic career and success as an entrepreneur for AV (autonomous vehicle) technologies have benefited directly from funding from the Federal agencies whose missions have been shaped by this Committee. These agencies and you have helped make possible a revolution in innovation that has helped to sustain U.S. economic leadership. I would like to acknowledge in particular Mark Dowd's leadership during the previous Administration in this regard.

My testimony today will highlight three key strategic elements that are vital to realizing a revolution in smart cities and mobility. One, continued U.S. commitment to advancing the basic sciences that underpin smart city, smart region innovation; two, a focus on integrating research and innovation with deployment at the regional level; and three, an emphasis on smart city strategies to create a supportive policy environment that blends workforce and rural development initiatives with innovation.

Smart city applications depend upon the integration of technologies that span the domain of cyber-physical systems. Fundamental research on cyber-physical systems, computer networking, AI and machine learning, robotics, human-machine teaming, cybersecurity, and privacy at NSF (National Science Foundation), DOT (Department of Transportation), DOE (Department of Energy), DOD (Department of Defense), NASA (National Aeronautics and Space Administration), and NIST (National Institute of Standards and Technology) will continue to be vital to advancing these capabilities.

This continued support of basic research should also be aligned with cross-disciplinary collaboration. Smart city innovations involve the science of systems integration. A smart city research initiative could include the development of a roadmap for filling gaps in the science of systems integration and interagency coordination.

My second key point is that fundamental research in enabling technologies needs to be effectively combined with application initiatives. At CMU, we refer to this model as research development and deployment, RD&D. We engage with local governments to identify mission targets, develop projects, and pilot solutions that can be scaled once proven successful.

For example, an initiative to deploy AI-enabled traffic signals to improve traffic flow and lower emissions started with nine intersections and is now being deployed in cities across the Nation. Our follow-on project enables persons with disabilities to use smartphones to communicate with traffic signals. The system can recognize their

presence and accommodate their small movements through the intersection, giving them confidence that they will have the time to cross safely.

The RD&D model also accelerates the technology transfer process. Carnegie Mellon started several startup companies emerging from our projects, which are disseminating innovation to cities across the Nation and beyond. The RD&D model also lends itself to creating networks of communities to share the best practices. The MetroLab Network established as a 501(c)(3) organization by CMU links together a virtual community of government-industry partnerships across the U.S. engaging more than 40 cities, 60 universities, and over 100 projects.

Another model of collaboration produced by Carnegie Mellon is the Smart Belt Coalition, an effort across Michigan, Ohio, and Pennsylvania to establish a dynamic and proactive collaboration that brings together universities, transportation authorities, and industry to foster a dialog and undertake specific projects that focus on informing the regulatory environment for connected and automated vehicles. Therefore, new funding that supports smart city initiatives should combine basic research with support for deployment initiatives such as grand challenges in specific funding areas.

My third key point is that smart city research initiatives should also focus on the effective policy building blocks to ensure broad adoption. One essential area is the critical need to build the workforce to support smart city development. This must include both a focus on specific technical degrees and focus on fostering community capacity building.

Funding research programs that incorporate educational components can have a catalytic impact on building the technical and community-based talent pipeline that smart city innovations depend on. The deployment of smart city innovation also creates a very natural pathway to engage communities and neighborhoods in STEM (science, technology, engineering, and mathematics) education.

Another major policy challenge that's impacted by the design of Federal science policy relates to the critical challenge of engaging rural and suburban communities in smart city innovations. For example, in the earliest phases of our AI traffic signal project, a suburban community was selected for a parallel deployment. Two years ago, Mobility21 launched a smart city challenge competition targeted to draw in participation from outlying suburban and rural communities while the competition fostered capacity-building collaboration between the university and communities across four neighboring counties.

Recently, with support from the DOE, Carnegie Mellon has launched an initiative to develop mobility solutions that address problems ranging from job and healthcare access to food insecurity in Greene County, a rural county of Pennsylvania with a high poverty rate and an elderly population. The targeted outcome is the piloting of a Rural County Mobility Platform that can be replicated in other counties.

Federal research agencies can enhance the growth of such collaborations in rural areas by incorporating grand challenges into

Federal smart city research initiatives, as well as supporting targeted education and outreach programs that incentivize urban, suburban, and rural collaborations. These efforts will be enhanced by national networking efforts that foster best practice learning, tech transfer, and innovation across communities.

In summary, the work of this Committee and the programs it has authorized have led to a technology revolution in computing, communications, autonomy, and artificial intelligence. The application of these breakthroughs to cyber-physical systems creates the potential to fundamentally improve the economic, social, and environmental fabric of our communities.

By focusing on a three-pronged effort to: A, increase core investments in foundational disciplines; B, foster greater interagency collaboration to support research, development, and deployment; and C, support agency strategies to incorporate workforce development and bring urban, suburban, and rural communities to collaborate, I believe this Committee and the Congress can have a dramatic positive impact on scaling the deployment of smart city innovations across America. Thank you.

[The prepared statement of Dr. Rajkumar follows:]

TESTIMONY

Raj Rajkumar
George Westinghouse Professor of Electrical and Computer Engineering, Director of the Metro21 Smart Cities Institute, and Director of the Mobility21 National University Transportation Center

PREPARED FOR
"SMART MOBILITY: IT'S A COMMUNITY ISSUE"
FIELD HEARING
OF THE HOUSE SCIENCE COMMITTEE
SUBCOMMITTEE ON RESEARCH AND TECHNOLOGY
Friday October 25, 2019

INTRODUCTION: SEIZING THE FUTURE THAT SMART CITIES CAN MAKE POSSIBLE

Good Morning Chairwoman Stevens, Ranking Member Lucas, and Members of the Committee:

Thank you for this opportunity to testify before this important hearing today.

My name is Raj Rajkumar. I am from Carnegie Mellon University in Pittsburgh, Pennsylvania where I am the George Westinghouse Professor of Electrical and Computer Engineering, director of the Metro21 Smart Cities Institute, and director of the Mobility21 National University Transportation Center.

I am pleased to be in Livonia. As with many of my colleagues, I have an intense personal and professional interest in smart cities, stemming from a career that began focused upon the transformation of the automobile—with research supported by General Motors since 2000. I therefore find it very appropriate to have this important dialogue in the heart of America's advanced transportation industry.

As my remarks will indicate, I strongly believe that the ability to advance smart city technologies and initiatives depends upon robust and sustained support for fundamental research. While research support is necessary, that in itself is not sufficient. How these technologies benefit our communities depends on how effectively we can deploy and integrate them.

Ultimately, our national well-being will rest in part on the ability to foster deployment and cross-regional collaboration. I currently have the privilege of collaborating with colleagues in Michigan on connected and automated vehicles. This hearing can serve to underscore how critical it is to foster collaboration across communities, researchers, institutions, industry, and technology components.

Let me first begin my remarks by expressing my personal gratitude to the work of this Committee. Virtually my entire academic career and my success as an entrepreneur have benefited from funding from the federal agencies whose mission has been shaped by this Committee's authorizing legislation. It is not an overstatement to express the view that you have helped make ongoing revolutions in innovation and sustained economic leadership possible.

The incredible advances in autonomous vehicle technology, reflected now in the tens of billions of dollars in private sector investments taking place in regions such as Michigan, Texas, California and my home in Pittsburgh, owe their roots to the decades of research support provided by agencies such as NSF, DOE, DOT, NASA and NIST, among others. The continuing work in these agencies is spearheading a revolution in smart city innovation. I would like to acknowledge, in particular, Mark Dowd's leadership during the previous administration in this regard.

This is a time to both imagine and seize the future. Let us assess the possibilities that smart city innovations hold:

- Imagine a community in which the lighting, heating and cooling of buildings is continuously optimized by data on traffic patterns that can predict when workers will arrive or leave.
- Imagine tens of millions of savings in infrastructure maintenance achieved by advanced condition monitoring, made possible not from costly built-in sensors but using data collected from regular fleet and auto traffic.
- Imagine being able to immediately translate data indicating very early signs of a potential flu outbreak to provide readily actionable and precise information to citizens in particular communities.
- Imagine the capacity to predict water main and other infrastructure breaks or fires before they occur to help municipalities prioritize projects and head off costly emergency repairs and damage.
- Imagine the ability for autonomous vehicle technology to also play a role in addressing the last-mile broadband challenge.
- Imagine a future where advances in materials and computational technologies allow the structural components of buildings to be programmed based on thermal sensing to optimize energy savings and enable sustainability.
- Finally, imagine that each of these initiatives helps create new pathways to STEM education in every neighborhood they touch.

Advances similar to these are already being piloted in regions across the nation. My testimony today will highlight three key strategic elements that are vital to realizing the full potential of this smart city revolution:

First, continued US commitment to advancing the basic sciences that underpin smart city innovation;

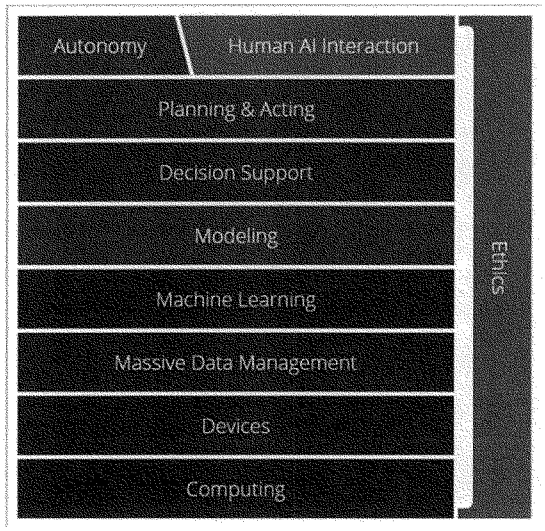
Second, a focus on integrating research and innovation with deployment at the regional level; and

Third, enhancing the capability of regional research initiatives to inform policy, incorporate information sharing across deployment communities, and launch workforce and talent pipeline development components are essential to accelerating deployment of smart city innovations, not only in cities but in communities of all sizes and characteristics.

INVESTING IN AND ADVANCING THE SCIENCE OF SMART CITY INNOVATIONS

Smart city applications are dependent upon the synergistic integration of a host of technological breakthroughs that span the entire domain of cyber-physical systems. At Carnegie Mellon, we refer to this integration challenge as the "AI Stack."

CARNEGIE MELLON AI STACK



The AI Stack captures the core enabling technologies that underpin smart city innovation. The "computing" and "devices" layers capture advances in computing power, innovations in the cost and effectiveness of networking technology, as well as sensing capabilities for perception such as LIDAR sensors ("Light Detection and Ranging," a remote sensing method that uses light in the form of a pulsed laser to measure distance).

The "machine learning" layer represents the data science elements of the Stack, including innovations in collecting and managing big data, increasingly at the hardware level and in cloud-computing operations. The "modeling," "decision support" and "planning & acting" elements of the Stack incorporate algorithmic advances for translating data analytics into recognizable patterns for prediction.

These combined capabilities then facilitate action---- either by autonomous systems, humans, or even better a combination of the two working together. Such autonomous systems range from autonomous vehicles and automated building systems to cognitive assistance tools such as advanced traffic, public health notices or data-informed strategies for optimizing infrastructure repairs.

Finally, as the AI Stack diagram highlights, the design and application of research in these domains must be informed by policy and ethics considerations across all these technology layers.

One example of the AI Stack at work can be found in one of the first major applications of Carnegie Mellon's Mobility21 National University Transportation Center: the development of AI-enabled adaptive traffic signals deployed across 150 intersections to improve traffic flow, reduce wait times and significantly reduce emissions. Uniquely, this system is entirely decentralized, with each node

communicating data to the others and adapting traffic flow throughout the network without any central control module.

This breakthrough relies on advances in camera technology (a sensor) as well as advances in the ability to compute at the device level—in this case at the individual traffic signal and across a network of signals. These traffic signals perform millions of calculations per second, converting images to data and running improved algorithms on that data in order to model traffic flow and plan to optimize it throughout the system in real-time.

In addition to capturing the fundamental science and technology elements of smart city applications, the AI Stack helps us envision a path forward for smart city research and development.

First, the AI Stack highlights the imperative of continuing research in the domains that the work of this committee has supported over the last few decades. For example, smart city innovation is dependent upon continued advances in the ability to compute at the "edge," which refers to the ability to process certain functions at the device level rather than across the system or in the cloud, saving bandwidth and improving latency. This includes hardware improvements and lower-cost sensing networks, the ability to train machine-learning algorithms on less data, the ability to generalize across similar data sets, and continued advances in human/machine teaming. This research field incorporates social and behavioral science including psychology, design, law, and other disciplines outside of computer science and engineering.

Fundamental research such as what this Committee has supported in cyber-physical systems, computer networking, AI and machine learning, robotics and human/machine teaming at NSF, DOE, DOT and NIST will continue to be vital to advancing these capabilities to improve the way we move in and interact with our physical communities.

This continued support of basic research in discrete fields should also be aligned with programmatic opportunities that foster cross-disciplinary collaboration. One of the key imperatives illuminated by the AI Stack model is the need to foster intense cooperation among researchers across these disciplines. Smart city innovations, like all elements of cyber-physical systems, involve the science of systems integration. A smart city research initiative across the federal government could include the development of a roadmap highlighting specific technical areas where foundational breakthroughs in integration are needed.

Through inter-agency coordination, funding could then be targeted both to these technical challenges and specific application areas. For example, coordination of sensing or edge computing research in NSF and DOE could both advance core technologies and combine them with a distinct focus on applications in areas such as urban environments or energy infrastructure. Similarly, advances in sensors, mapping and AI will make autonomous vehicles safe, secure, reliable and fuel-efficient. This roadmap-grounded approach to interdisciplinary and cross-agency coordination could also enhance the ability to integrate social science, privacy and ethical considerations into both research and education as unique questions around application and deployment arise.

COMBINING RESEARCH AND DEVELOPMENT WITH DEPLOYMENT

In addition to highlighting the need for a framework for interdisciplinary research within its layers, the AI Stack also illustrates the imperative for fostering collaboration among technical researchers in those layered fields with domain experts in application areas. An example of this is having computer modeling and simulation researchers collaborate with experts in emergency and disaster response planning.

We refer to this collaborative model as Research, Development and Deployment (RD&D). As embedded in CMU's USDOT Mobility21 National University Transportation Center, this RD&D model focuses on creating formal mechanisms for engaging with local governments to identify research targets, and developing projects and pilot solutions that can often be scaled once proven successful.

The strength of the RD&D model is that it identifies problems needing to be addressed, usually along with data or new potential datasets from government agencies, and brings them to inter-disciplinary teams of researchers.

Through formal agreements with the City of Pittsburgh, the County of Allegheny and the Pittsburgh International Airport Authority, our Mobility21 National University Transportation Center and the Metro21 Smart Cities Institute have been able to pilot a variety of advances that have focused on specific city challenges. Each of these projects was initiated through a formal process in which the governmental entity identifies specific problems and the university manages a process of engaging faculty to propose solutions. Very often, faculty from multiple disciplines form a unique team to respond to these problems. These teams often map to disciplines across the AI Stack, and in turn engage with those in the community having domain expertise.

Returning to the example of the research. development and deployment of AI-enabled traffic signals, this initiative required the domain expertise of traffic engineers as well as community leaders who brought important values to the program, such as how the signals should accommodate the needs of pedestrians, bicyclists and public transit vehicles. The project began with nine intersections but continues to scale and is now projected to connect 200 intersections by 2020.

Additionally, one of the most powerful follow-on projects that this deployment-focused engagement produced was the development of smartphone capabilities that empower persons with disabilities to communicate with the traffic signals. By enabling the systems to recognize the presence and location of these users, the system can adapt the signal change cycles to accommodate their movements and location within the intersection, giving them greater confidence that they will have enough time to cross the intersections safely.

Because the CMU Mobility21 team also includes The Ohio State University, the University of Pennsylvania and the Community College of Allegheny County, it has the ability to leverage capabilities and build experiences across different geographic and demographic environments. Our RD&D model is focused on advancing specific technologies as well as on building the systems of systems that are so vital to scaling smart city applications.

The RD&D model also accelerates the technology transfer process. Carnegie Mellon has been able to launch several start-up companies emerging from its UTC projects. These start-ups are now disseminating these innovations to cities across the nation and internationally.

Examples of other RD&D pilots include the following projects:

- Improve and automate infrastructure monitoring through the use of machine learning, perception and smartphone technologies that convert images to data.
- Reduce automotive emissions using latency-aware cloud-based route planning.
- Predict and reduce structure risk for commercial buildings by leveraging historical fire incident and inspection data.
- Better plan spatial use for pedestrian traffic in busy thoroughfares in order to enhance traffic flow and safety by using advanced computer vision and machine learning.
- Detect signs of impending landslides by utilizing deep learning combined with computer vision.

Yet another advantage of the RD&D model is the ability to scale these innovations and best practices by networking experiences across communities. To enhance this dynamic, Carnegie Mellon helped establish the Metro Lab Network, a 501(c)3 organization. The MetroLab Network links together a virtual community of government/university partnerships across the US, engaging more than 40 cities, 50 universities and over 100 projects, ranging from transportation applications to the application of data-driven systems to create real-time interactions between physicians and emergency service providers.

Another model of collaboration in which Carnegie Mellon is involved can be found right here in Michigan. The Smart Belt Coalition is a broader regional effort among Michigan, Ohio and Pennsylvania to establish a dynamic and proactive collaboration in this region for the development of connected and automated vehicles. The coalition brings together universities, transportation authorities and industry to foster dialogue and undertake specific projects that focus on informing the regulatory environment for the deployment of AV technologies.

These examples, and similar initiatives such as the NIST- supported Global Cities Challenge, are establishing a smart city tech transfer ecosystem that will help future research initiatives to yield tangible economic and social benefits.

ADVANCING SMART CITY INNOVATIONS THAT CAN ENHANCE THE DEVELOPMENT OF SMART CITY POLICIES

By bridging multiple regulatory jurisdictions, the RD&D networks mentioned above also help to advance the dialogue on policy issues, which is vital to widespread adoption of smart city applications.

Smart city technologies, by definition, thrive in the fabric of communities and hence depend upon the creation of a policy framework that can enable and accelerate scalable deployment. Some elements of this framework rest in major policy processes related to broadband, spectrum allocation and communications policies; standards and interoperability provisions.

Other elements of this policy framework spring from the research and innovation environment and can be shaped directly by federal science policy.

The first of these policy elements is the critical need to build the workforce and talent pipeline to support smart city development. This must include both a focus on specific technical degrees and fostering broad community capacity.

The experience derived from Carnegie Mellon's Metro21 Smart Cities Institute and the Mobility21 Transportation Center suggests that this requires a broad-based strategy. Elements of CMU's workforce pipeline strategy include the following:

- Infusion of smart city curricula and project experience across several disciplines at the university—computer science, engineering, business, public policy and the social sciences.
- The use of grand challenges and robust hackathons to foster cross-disciplinary education opportunities and stimulate early student engagement with community and governmental partners.
- The development of targeted initiatives to engage women and under-represented minorities in smart city research and career opportunities.
- Strategic support for robotics, transportation and other related smart city clubs and school-based initiatives in both urban and rural communities.

Research programs and initiatives across federal science agencies that incorporate educational components can have a catalytic impact on building the technical and community-based talent pipeline that smart city innovations depend on. The deployment of smart city innovation, from traffic signal improvements and infrastructure monitoring to predictive capabilities to improve city services, creates a natural pathway to engage communities and neighborhoods in STEM education.

A second major policy challenge that can be impacted by the design of federal science policy relates to the critical challenge of engaging rural and suburban communities in smart city innovations. From the very beginning of Carnegie Mellon's University Transportation Center activities, we have sought to initiate and perfect models for engaging communities outside of the urban core. For example, in the earliest phases of the adaptive traffic signal project, a suburban community was selected for a parallel deployment.

Two years ago, Mobility21 launched a smart city challenge competition specifically targeted to draw in participation from outlying suburban and rural communities. Awarding over $700,000 in projects in 10 communities in 4 counties, the competition has fostered capacity-building collaboration between the university and these communities.

Recently, with support from the Department of Energy, Carnegie Mellon has launched an initiative to bring a more systematic level of collaboration in smart transportation innovations to a rural county project. Greene County, a county that is more than 90% rural and has some of the highest poverty rates in Pennsylvania, will benefit from a collaboration among Mobility21, the county and Waynesburg University, located in the county seat. The goal is to develop mobility solutions that address problems ranging from job and healthcare access to food insecurity. The targeted outcome is the piloting of a Rural County Mobility Platform (RAMP) that can be replicated in other counties.

The key to each of these initiatives is the ability to form collaborations with partners in these communities, who bring both local domain and capacity-building expertise. As the Greene County project highlights, these partners can be units of government, academic institutions, private entities such as foundations, and private industry such as employers or service providers.

Federal research agencies can enhance the growth of these types of collaborations in rural areas by incorporating grand challenges into federal smart city research initiatives as well as supporting targeted

education and outreach programs that incentivize urban/suburban/rural collaborations. As I mentioned earlier, these efforts will be greatly enhanced by national networking opportunities that foster best-practice learning, tech transfer and innovation across communities.

CONCLUSION: AN INFLECTION POINT FOR SMART CITY INNOVATION

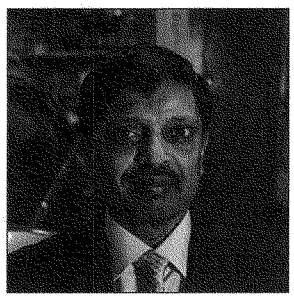
The work of this Committee and the programs it has authorized have led to a technology revolution in computing, communications, autonomy and artificial intelligence. The application of these breakthroughs to cyber-physical systems creates the potential to fundamentally improve the economic, social and environmental fabric of urban, suburban and rural communities.

Support from the agencies authorized by this Committee has enabled my colleagues and me at Carnegie Mellon to begin to realize the potential of these innovations in Pittsburgh, Pennsylvania and the communities of our partners across the nation. It is very gratifying to me as a basic science researcher to be a partner with these agencies in ensuring that federal research funding in basic science is having both a broader and a more immediate impact on the lives of US citizens through innovative RD&D models.

By focusing on a three-pronged effort to (a) increase core investments in the foundational disciplines of smart city applications, (b) foster greater interagency collaboration to support research, development and deployment models, (c) support agency strategies that incorporate talent and workforce development, and bring urban, suburban and rural communities to collaborate in research programs, I believe this Committee and Congress can have a dramatic impact on scaling the deployment of these innovations across America.

Thank you.

Carnegie Mellon University



Dr. Raj Rajkumar is the Director of the Metro21 Smart Cities Institute, the T-SET National USDOT University Transportation Center for Safety, Mobility21, a USDOT National University Transportation Center for Mobility. Raj is the George Westinghouse professor at CMU's Department of Electrical and Computer Engineering. Raj also serves as Co-Director of the General Motors-Carnegie Mellon Information Technology Collaborative Research Laboratory.

Dr. Rajkumar's work is primarily in cyber-physical systems, such as autonomous driving and vehicular networks, and wireless/sensor networks, including the creation of Nano-RK, the reservation-based real-time operating system (RTOS). Raj has won six best paper awards, and his paper on Priority Inheritance Protocols proposed a solution to 'priority inversion problem,' allowing for the success of the 1997 Mars Pathfinder Mission.

Rajkumar's research interests include but are not limited to operating systems, scheduling theory, resource management, wired/wireless networking protocols, quality of service management, hardware/software architecture, model-based design tools and power management. In the context of wireless/sensor networks, his research interests span hardware, devices, power-efficient networking protocols, run-time environments, large-scale system architectures, visualization and administrative tools.

Rajkumar has received multiple awards, including the Carnegie Science Award in Information Technology, the Steven J. Fenves Award for Systems Research from the Carnegie Institute of Technology, and the Outstanding Technical Achievement and Leadership Award from the IEEE Technical Committee on Real-Time Systems. He has been named a Fellow of the Institute of Electric and Electronics Engineers and a Distinguished Engineer by the Association for Computing Machinery. He has received multiple best paper awards, spoken at various conferences and events, been a member or chair of professional committees and conferences, and consulted for several companies. Rajkumar is a member of the editorial board of Real-Time Systems Journal and previously served on the editorial board of IEEE Transactions on Image Processing.

Chairwoman STEVENS. Fabulous, thank you.

Dr. Bills, I'm going to recognize you for 5 minutes of testimony.

TESTIMONY OF DR. TIERRA BILLS, ASSISTANT PROFESSOR, CIVIL AND ENVIRONMENTAL ENGINEERING, COLLEGE OF ENGINEERING, WAYNE STATE UNIVERSITY

Dr. BILLS. Thank you, Chairwoman Stevens and Members of the Committee, for inviting me here to testify today. As mentioned earlier, I'm an Assistant Professor in civil and environmental engineering at Wayne State University, and it is my pleasure to share about my current research on smarter transportation technologies and their usefulness for addressing transportation inequity.

Much of my current research focuses on investigating the social impacts of transportation projects. My latest project, for which I'm a co-investigator, is funded by the National Science Foundation, and it aims to improve the ability to represent the distinct travel needs of transport-disadvantaged communities. And this is using mixed modes of sampling and data collection. My objective is not only to provide a clear picture of how transportation systems affect society but to support a design of more sustainable transportation interventions that meet the needs of all segments of society.

As we know, smarter transportation technologies, which range from GPS data generation to connected autonomous vehicle technology, are transforming our transportation landscape as we know it today. These technologies hold the promise of significantly reducing traffic incidents and traffic delay and enabling new and more far-reaching transportation services in terms of ridesharing, shared ridership, and micro-transit.

However, few research efforts and industry efforts have focused on potential benefits and impacts to transportation-disadvantaged communities, and these are low-income, minority, and transit-dependent travelers. And without efforts to investigate how well smart transportation solutions and connected autonomous vehicle technologies can serve as solutions for addressing the broadest set of needs for society, we risk excluding those with the greatest transportation needs from the vast benefits of smarter transportation technologies and potentially reinforcing patterns of decline and underemployment for struggling cities across the United States.

The recent project, the NSF project, is titled "Data-Informed Scenario Planning for Mobility Decision-Making in Resource-Constrained Communities." This is a 4-year research effort, and the project is being undertaken by a partnership of faculty researchers and students and stakeholders across the University of Michigan, Georgia Tech, Wayne State University, and Howard University.

This project is motivated by the need to understand how smart mobility solutions can be leveraged to empower community-based decisionmaking around solutions for these communities. The emphasis here is on low-income, resource-constrained communities in particular because of the promise of smart mobility that can lead to significant gains in quality of service delivery, even under resource constraints. The project is designed to impart the community with the capacity to define and deploy mobility solutions that

support greater accessibility to employment opportunities, education, and health care.

There are four clear objectives of this project. First is to define a cost-effective data-collection strategy that assesses the performance of the transit system in Benton Harbor, which is where this research is based; track mobility patterns of residents; and acquire resident perceptions of their mobility. Second is to use that data to collect and calibrate analytical models and predict resident demand for mobility services. Third is to implement a community-based decisionmaking framework based on scenario planning methods and smart mobility technologies, data visualization, predictive analytics used in the process of predicting these outcomes. And finally, to implement a consensus mobility solution and assess the impact.

My primary role in this effort is to design and estimate components of what is called a travel demand model, and the key here is that individual data collected in order to estimate these models represent the travel behaviors of various demographics and segments in the community, and therefore, the ability to accurately predict travel choices and outcomes for all population segments is tied to how well these segments are represented in the travel data set and for model estimation.

So a major contribution of this effort is to define the extent to which new data collection methods and novel community engagement approaches can improve representation of these target groups in our travel demand models. And this is essentially a pressing issue with regard to under-resourced communities like Benton Harbor.

So far to date we are 1 year into our project, and our survey data collection approach, which is a distinguishing factor of our study and travel model development, employs a mixture of traditional and electronic survey modes in order to achieve a higher representation of transport-disadvantaged communities. Prior work that we've done validates the soundness of this approach.

And the focal point of this data collection approach is a series of 2-hour survey workshops that provide a personal point of contact for survey respondents. In these workshops research staff, trained facilitators, are made available to assist the participants in completing the activity survey, as well as registering for activity survey data collection using GPS.

To date, we've accomplished a total of four of these data-collection workshops, and this resulted in a total of 140 survey respondents. And the most important takeaway here is that there are at least 40 percent of our respondents would not have been able to participate in these surveys had we not offered and emphasized a mixture of data collection efforts. Thank you.

[The prepared statement of Dr. Bills follows:]

25 October 2019

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

Hearing Title: **"Smart Mobility: It's A Community Issue"**

Dr. Tierra Bills
Assistant Professor
Transportation Engineering
Department of Civil and Environmental Engineering
Wayne State University

Thank you Chairwomen Stevens and members of the Committee for inviting me here to testify today.

I am an Assistant Professor in the Civil and Environmental Engineering Department at Wayne State University and it is my pleasure to share about my current research on smarter transportation technologies and their usefulness for addressing transportation inequity.

I will start with a statement about my background: I joined Wayne State (in Summer 2019) after spending 3 years as a Michigan Society Fellow and Assistant Professor at the University of Michigan. Much of my current research focuses on investigating the social impacts of transportation projects. I develop (activity-based) travel-demand models to investigate individual and household-level transportation-equity effects, for the purpose of designing transportation systems that will provide more equitable returns to society. My latest projects (Funded by NSF and Ford Motor Company) aim to improve the ability to represent the distinct travel needs of transport disadvantaged communities in, using mixed modes of sampling and travel data collection. To date, I find that scientists and practitioners have simply not done a good job with collecting representative travel behavior data across segments of the population, which brings to question our ability to model and represent transportation related outcomes for vulnerable population segments. In order to bridge this gap, my work focuses on the research spectrum from data collection, to model development and prediction, to transportation decision-making. My objective is not only to provide a clearer picture of how the transportation system affects society, but to support the design of more sustainable transportation interventions to meet to needs of all segments of the population, currently and for future generations. My research interests generally include discrete choice analysis and behavioral modeling, transportation equity, transportation planning, and emerging data sources in transportation modeling. I hold a B.S in Civil Engineering Technology from Florida A&M University ('08), and M.S ('09) and PhD ('13) degrees in Transportation Engineering from the University of California, Berkeley.

Introduction

Smarter transportation technologies – ranging from GPS data generated from smartphone usage, to connected and autonomous vehicle (CAV) technology - are transforming our transportation landscape as we know it today. These technologies hold the promise of significantly reducing traffic incidents and traffic delay, and enabling new and more far reaching transportation services (e.g. ride-sourcing, shared ridership, and microtransit). However, few research and industry efforts have focused on potential benefits/impacts transport disadvantaged communities (low income, minority, and/or transit dependent travelers). Without efforts to investigate how well smarter transportation and CAV technologies can serve as solutions for addressing the broadest set of travel needs among society (e.g. controlling for income and accessibility constraints), we risk excluding those with the greatest transportation needs from the vast benefits of smarter transportation technologies, and potentially reinforcing patterns of decline and underemployment for struggling cities across the United States.

SCC – NSF Project

The research project titled "Data-Informed Scenario Planning for Mobility Decision Making in Resource Constrained Communities, " is a 4-year research effort, funded through the National Science Foundation's Smart and Connected Communities program. The project is being undertaken by a partnership of Faculty, researchers, and students across several universities (including University of Michigan, Georgia Tech, Wayne State University, and Howard University) as well as a network of public and private stakeholders in and around to City of Benton Harbor, Michigan. This project is motivated by the need to understand how smart mobility solutions can be leveraged to empower community-based decision making around solutions to community transportation needs. The emphasis here in on low income, resource constrained communities in particular, because of the promise that smart mobility solutions can lead to significant gains in the quality of City service delivery, even under resource constraints.

The project is designed to impart the community with the capacity to define and deploy mobility solutions that support greater accessibility to employment opportunities, education, and healthcare. The projects four primary objectives are:

- Define a cost-effective data collection strategy that can assess the performance of the Benton Harbor transit system, track the mobility patterns of residents, and acquire resident perceptions of their mobility.
- Use the mobility data collected to calibrate analytical methods that predict resident demand for mobility services and the performance of these services given changes in user demand.
- Implement a community based decision-making framework, based on scenario planning methods with S&CC data visualization and predictive analytics used in the process to predict outcomes of considered scenarios.
- Implement consensus mobility solutions and assess their impact.

Why Benton Harbor

An existing engagement between the University of Michigan and the community of Benton Harbor, Michigan provided a strong foundation for this NSF project work. In October 2016, the University of Michigan Smart and Healthy Cities Initiative held a workshop on mobility in Benton Harbor, Michigan, and invited residents, government officials, and business community representatives to discuss transportation needs in Benton harbor. Benton Harbor (pop. 10,036) is a small city that stretches 4.7 square miles, and is located off the southwestern coast of Michigan. The common feeling among community members was that many residents either remain under/unemployed or are losing jobs due to unreliable transit service. However, only limited public access data exists on the quality of Benton Harbor's transportation system for measuring the system's progress toward real goals for improvement. In recent decades, Benton Harbor has fallen into a state of population and economic decline and is now one of the poorest communities in Michigan, with a per capita income of $10,309 and 50.3% of residents living below the poverty line. St. Joseph (the "twin city" to Benton Harbor) sits in stark contrast with a per capita income of $36,233 and 8.7% of residents living below the poverty line [1]. For these reasons and with the City's deep concerns about improving access to employment destinations in the region, this research was established to impart smart, meaningful, and sustainable transportation solutions.

Why focus on Transportation Equity?

Transportation equity analysis referrers generally to a process and set of tools for estimating the distribution of impacts resulting from transportation investment [2], and determining whether this result is fair or equitable. This is also sometimes referred to as Environmental Justice Assessment. This analysis is mandated at the Federal level by two pieces of legislation. First in the 1994 Executive Order 12898, "Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations," which directs Federal agencies to adopt Environmental Justice as a mission, and seek to address equity related impacts of all programs, policies, and activities, vulnerable (e.g. low income and minority) communities. Second, Title VI of the Civil Rights Act of 1964, states that "No person in the United States shall, on the grounds of race, color, or national origin, be excluded from participation in, be denied the benefits of, or be subjected to discrimination under any program or activity receiving Federal financial assistance" [3].

Transportation equity analysis using accessibility as the indicator is not new. A study by [4] assesses the equity implications of bus rapid transit in Cali, Colombia, where they measured the distribution of transit access for five population segments. A study by [5] developed an equity measure for public transit equity and sought to maximize transit coverage based on the need of transit dependents. Further, [6] applied the Lorenze Curve/ Gini Index to measure the difference between an equal distribution of benefits (accessibility) to the observed distribution. Some studies have also focused on the issues around transportation equity in Detroit [7, 8], where gravity-based accessibility measures were applied to assess the distribution of employment accessibility across various sociodemographic groups. Yet, questions still remain about the potential to reduce inequities in accessibility through new smart mobility innovations like CAV and microtransit.

My Research

My particular role is this effort it to design and estimate components of an activity-based model (ABM) to define and model the demand-side response of Benton Harbor residents to proposed transportation solution. The ABM is an established transportation planning tool designed to model how people choose their travel modes on a daily basis [9]; they are the latest innovation in travel demand modeling and are fast becoming the standard in both research and practice [10]–[14]. In general, travel demand models serve as advanced transportation planning tools for measuring and forecasting fine-grain travel responses to large-scale transportation investments, such as system-wide transit improvements or new transit alternatives. These models link the effects of transportation system and land-use changes to various individuals' choice dimensions (*e.g.,* auto ownership, destination, time-of-day). ABMs estimate realistic travel choice outcomes by assigning behavior into a set of travel choice dimensions and models each using a (logit) discrete choice model. These travel choice dimensions include work location, auto ownership, (daily) activity pattern, time-of-day, stop location, and mode choice dimensions.

The principle of utility maximization for each travel choice dimension guides the mathematical form of the discrete choice travel model. The decision maker (*i.e.,* traveler) assigns a level of utility to each travel alternative in the choice set and selects the alternative that provide their highest level of utility. The expression for each alternative's utility includes parameterized observable variables (characteristics of the decision maker and attributes of the alternative). The parameters associated with each of the variables are estimated from a sample of travel activity data (representing choices made by the decision makers when presented with choice). These represent the value that the decision maker associates with the variables when choosing an alternative. The key here is that individual data used for utility estimation (and therefore the estimated choice outcomes) represent the travel behaviors of the various demographic segments of a community. Therefore, the ability to accurately predict travel choices and outcomes for all population segments is tied to how well such segments are represented in the travel dataset used for model estimation.

A major contribution of this effort is in determining the extent to which new data collection methods and novel community engagement approaches could improve the representation of target group behavior in ABM results. This is an especially pressing issue when applying ABM to small, under-resourced communities like Benton Harbor. In particular, there are two potential causes of severe underrepresentation of groups (such as low-income households, un- and under-employed travelers, and transit dependents) that motivate the travel survey design presented here. First, is the *digital divide* [15] which defines the socioeconomic disparity in access and ability to use communication technologies (*e.g.,* internet, smartphones). With the progression of travel survey data collection moving rapidly toward electronic modes [16], known challenges with the *digital divide* raises concerns about accessing input from specific groups. This raises questions about how well the travel behaviors of target groups (namely, transport disadvantaged communities) are represented in emerging travel data sets. Second, unit nonresponse in household travel surveys

(*i.e.*, complete nonparticipation of a potential respondent, perhaps due to digital divide issues) can result in significant biases that propagate through to demographic summary statistics from the data sample, even after applying standard household weighting adjustments [17].

Our survey data collection approach – a distinguishing factor in our study and travel model development – employs a mix of traditional and electronic survey modes in order to achieve higher representation for transport disadvantage communities. Prior work in Benton Harbor validates the soundness of the approach. The focal point of this data collection approach is a series of 2-hr survey workshops, offered to provide a personal point of contact for survey respondents. At these workshops, research staff and trained facilitators are available to assist participants in completing the activity survey (given a choice of the paper or online version using on-site computers) and then registering for the 1-week GPS survey. The strategy includes a $15 visa gift card as incentive for each participant who completes both surveys.

Preliminary Results

As of October 2019, we have completed a total of 4 data collection workshops in Benton Harbor (this most recent of these being 9/25/19), resulting in a total of 134 survey respondents. Of these respondents, 40 were GPS tracked. While these are small sample sizes, it is clear that the respondents to the paper version of the survey respondents were found to be more transit dependent (35% rely solely on the TCATA system) compared to the online respondents. This demonstrates the significance of offering multiple survey modes, as more than one third of the survey respondents were found to be transit dependent; this is our target group who would have gone underrepresented in the sample had online surveys been relied on solely. Current ongoing efforts include planning for the next workshop, processing existing data to identify distinct travel groups in preparation, and estimating components of the activity-based travel demand model.

Other Research on Smart Mobility and Equity

One of my other research efforts aims to understand how well microtransit can directly address transportation equity issues. Recent study on the benefits of shared mobility suggests that new microtransit services have the potential to help mitigate transportation equity issues and this may hold significant promise for addressing poor transportation accessibility experienced by disadvantage communities. This has long been a pain point for the City of Detroit, where communities experience drastic differences in employment accessibility based on location, racial and income classes, and auto ownership/ transit dependent status. However, the solution may not be as simply as installing more shared mobility. Important questions remain about how well microtransit service can align with specific communities needs and may affect the gap in accessibility between vulnerable and affluent communities.

In this study (Funded by Ford Motor Company) makes two significant contributions: 1) we evaluate multimodal transportation accessibility across the 7-County Metro Detroit Region, with

specific attention to the differences in accessibility within the City of Detroit and the remainder of the Detroit Region, and we perform an equity analysis along two social dimensions; income and auto ownership. We also 2) implement a scenario analysis of the equity impacts of a hypothetical micro-transit alternative in Detroit. The analysis is performed using the Southeast Michigan Council of Government's travel demand model for the Detroit region.

While this study is ongoing, our preliminary results suggest that without close attention to cost structure and affordability, microtransit may not provide the much needed accessibility gains for transport disadvantaged communities in comparison to more affluent communities. Further study assessing the potential effects of realistic microtransit scenarios (with realistic cost structures), coupled with appropriate policy interventions are warranted.

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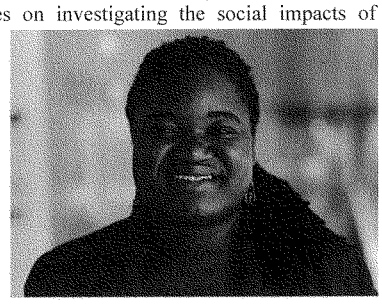
Tierra Bills Bio:

Dr. Tierra Bills is an Assistant Professor in the Civil and Environmental Engineering Department at Wayne State university. She has recently joined Wayne State (in Summer 2019) after spending 3 years as a Michigan Society Fellow and Assistant Professor at the University of Michigan.



Much of Dr. Bills' current research focuses on investigating the social impacts of transportation projects. She develops activity-based travel-demand models to investigate individual and household-level transportation-equity effects, for the purpose of designing transportation systems that will provide more equitable returns to society. Her latest project aims to improve the ability to represent the distinct travel needs of transport disadvantaged communities in Benton Harbor, Michigan, using mixed modes of sampling and travel data collection. This work further seeks to determine the extent to which transit improvements can influence employment outcomes for Benton Harbor residents. To date, practitioners have simply not done a good job with collecting representative travel behavior data across segments of the population, which brings to question our ability to model and represent transportation related outcomes for vulnerable population segments. In order to bridge this gap, Dr. Bills' develops modeling approaches for measuring the distribution of impacts from various transportation investments, across society. This is not only to provide a clearer picture of how the transportation system affects society, but to support the design of more sustainable transportation interventions to meet to needs of all segments of the population, currently and for future generations. Her other areas of interest include Transit Reliability and emerging data sources for travel demand modeling.

Dr. Bills research interests generally include discrete choice analysis and behavioral modeling, transportation planning, and emerging data sources in transportation modeling. Dr. Bills holds a B.S in Civil Engineering Technology from Florida A&M University ('08), and M.S ('09) and PhD ('13) degrees in Transportation Engineering from the University of California, Berkeley.

Chairwoman STEVENS. Great, thank you.
Mr. Averitt, we'll recognize you for 5 minutes of testimony.

**TESTIMONY OF MR. SCOTT AVERITT,
TECHNICAL EXPERT AND MANAGER OF PUBLIC/PRIVATE
PARTNERSHIPS, ROBERT BOSCH LLC**

Mr. AVERITT. Good morning, Chairwoman Stevens and Congressman Cloud and Congressman Foster. Thank you for the opportunity to testify before you today.

As Chairwoman Stevens introduced me, my name is Scott Averitt. I work for Bosch here in Farmington Hills as a technical expert and manager of public-private partnerships. Bosch is a global company with roughly 410,000 employees spread across more than 60 countries around the world. We first established a presence in the U.S. in 1906 and currently employ nearly 35,000 associates in more than 100 locations in North America. We have technologies across all four different business sectors that are applicable toward smart mobility and smart communities.

Our vision for a smart city is to create an interconnected ecosystem that works to optimize performance, increase efficiency, and enhance quality of life for all. In order for smart community solutions to be successful, they must be borne out of people's experiences and needs. Bosch draws upon a user experience-driven process to develop our products and services.

One of the fundamental truths that defines a thriving community is the accessibility to safe and efficient mobility. For example, our recent grant submission to the U.S. Department of Transportation, in partnership with the Michigan Department of Transportation, aims to achieve this.

Through the deployment of Bosch's video-as-a-sensor solution, our cameras will increase pedestrian and vehicle safety through detection, prioritization, and alerts of pedestrians and cyclists. Additional technologies from our partners will help to reduce traffic incidents and congestions through the use of vehicle-to-vehicle and vehicle-to-infrastructure communications. The benefits include reduced emergency vehicle response times and public transportation on-time performance.

Additionally, Bosch cameras will be used to identify wrong-way drivers. The system will use communications and digital signage to send out alerts to the driver and to nearby travelers to mitigate risk and save lives. The intelligent video analytics embedded in our cameras can also help cities with tasks such as curbside management, delivery zone violations and availability, parking analytics, and double parking detection.

Bosch has partnered with the Ohio Department of Transportation regarding deployment and testing of technologies along the U.S. 33 Smart Mobility Corridor. Video analytics are being used to generate warnings for cross-traffic, curve speed, exit ramp queue, red light violation, work zones, along with detection and notifications for pedestrians and wrong-way drivers. These technologies are applicable and scalable from big cities to small cities to rural communities.

As part of a recent USDOT grant awarded through the Ohio Department of Transportation, Bosch is the technology provider on a

project that will test and deploy driver assistance systems in the form of truck platooning. The technologies to be deployed are expected to help cities, suburban areas, and rural communities through improved road safety, decreased fuel consumption, and improved freight logistics efficiency. Freight shipping is essential to the success of many industries. Therefore, it is critical that we continue to innovate and transform this industry in a sustainable way.

Personal mobility solutions should be scalable and accessible to all. Bosch's eBike system aims to extend cycling accessibility to a wider range of commuters. Bosch's pedal assist motor drive engages only when pedaling. This enables precise assisted speeds of up to 28 miles per hour with hands-free, no-throttle operation. eBikes essentially flatten hills, shorten distances, and provide a viable option to ride for those who otherwise could not.

The Bosch 'n Blue Program has been successfully implemented across the country. This program provides specially outfitted eBikes to police departments as a trial period to augment their mobility fleets. Police departments have praised advantages of increased range, higher speeds, and incredible flexibility. eBikes are a great way for officers to engage with the community while still quickly and safely getting to where they are needed.

Vehicle parking continues to be a challenge for drivers and communities alike. Bosch's smart parking solution detects parking availability for garages, lots, and on street. The camera solution performs dual functionality by providing security video and parking spot detection. Parking management software and dashboards make it easy to share parking availability via signage and customer-specific apps to the community. More efficient parking systems help to reduce vehicle traffic from circling the block looking for a spot. It improves driver experience leading to greater return customers and improved parking spot utilization rates.

Our cameras use onboard intelligent video analytics to generate a separate data stream that provides information about object identification, classification, and path of motion. This method preserves privacy by not sending real live video and also reducing the backend communication bandwidth requirements.

Thank you for your time today, and I——

Chairwoman STEVENS. Thank you.

Mr. AVERITT [continuing]. Am looking forward to answering questions.

[The prepared statement of Mr. Averitt follows:]

Testimony of Scott Averitt

Technical Expert and Manager of Public/Private Partnerships

Robert Bosch LLC

Field Hearing: Smart Mobility: It's a Community Issue

House Committee on Science, Space and Technology

United States House of Representatives

October 25, 2019

Robert Bosch LLC
Testimony before the House Committee on Science, Space and Technology
October 25, 2019

Good Morning Chairwoman Stevens, Ranking Member Baird, members of the Committee...Thank you for the opportunity to testify before you today. My name is Scott Averitt and I work for Bosch in North America as a technical expert and manager of public/private partnerships.

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Thank you once again for your time today and I would be happy to answer any questions you may have.

Support Information

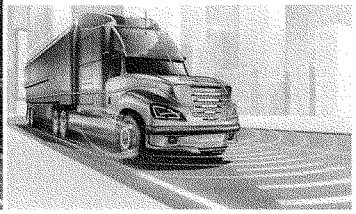
Overview of Bosch's Smart Community Initiatives in the U.S.

Bosch's Overall Approach: Provide services, solutions and technical expertise from across Bosch's business sectors to achieve a holistic and connected community, which is highly efficient, sustainable, and provides residents with a high quality of life. The Bosch Smart Community vision includes the following areas:

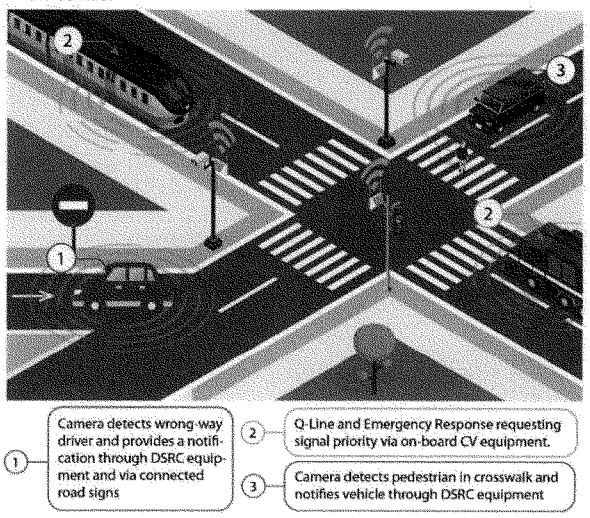
- **Energy:** Building energy storage, energy-efficient heating, hot water & cooling systems (residential, commercial, industrial, campus wide), geothermal HVAC systems, energy-efficient appliances, distributed energy generation through Solid Oxide Fuel Cells (SOFC).
- **Buildings:** Building Management Platform, video surveillance, fire alarm systems, Energy Management Platform, elevator monitoring, occupancy detection, heat mapping.
- **Security:** Intelligent video analytics, video systems, access control, public address system, intrusion alarm systems, gun-shot detection, perimeter security, critical infrastructure security.
- **Mobility:** Intelligent Transportation Systems (smart parking, wrong-way driver detection, pedestrian detection, curbside management, V2X, cybersecurity), autonomous & connected vehicle systems, EV-mobility, eBikes, eScooters.
- **Smart Community:** Micro-Climate Monitoring, Community App & Community Portal.

Current and pending project examples:

1) **DOT Grant awarded to Ohio Department of Transportation (ODOT) and DriveOhio to test and deploy Automatic Driving System technology in Ohio.**
   - Bosch is a sub-awardee on this project as a technology provider for level 1 & 2 autonomous functionality to enable truck platooning.
   - Benefits of Truck Platooning
     - Improved road safety
     - Decreased fuel consumption
     - Improved freight logistics efficiency resulting in positive economic impact

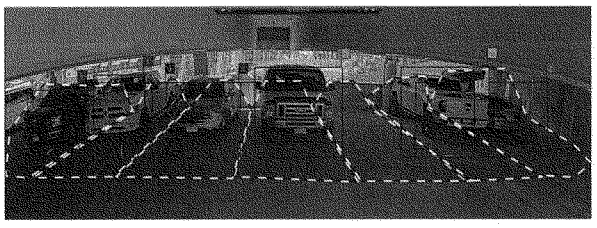


2) **MDOT project submission to US DOT ATCMTD grant opportunity for the "Intelligent Woodward Corridor Project".** M-1 Woodward Avenue from Campus Martius Park to I-696.
   - Bosch is a partner on this submission to provide our "Video as a Sensor" product solution.
   - Key Technologies: 1) Pedestrian detection, prioritization, and alerts; 2) Traffic intersection preemption and signal priority for authorized vehicles; 3) Vehicle to Vehicle (V2V) and Vehicle to Infrastructure (V2I) communications; 4) Transportation system optimization through data analytics and edge computing; 5) Wrong way driver detection and alerts.
   - Benefits
     - Improved pedestrian and vehicle safety including detection and warning regarding wrong way driver incidents.
     - Reduced response times for emergency vehicles.
     - Improved on-time arrivals for public transportation including the Qline and public busses.
     - Reduced congestion for public transportation, freight deliveries, and commuters.
     - Better management of pedestrian and vehicle traffic surrounding events along the corridor



3) **Bosch project proposal to NSF's Smart & Connected Communities funding opportunity for "Lake Nona Connect: Developing Innovative Solutions to Build a Healthy Integrated Community".**
   - Partnership with the University of Central Florida (behavioral science center) and Tavistock Development Company.
   - Lake Nona is a master plan community near Orlando Florida.
   - The goal of Lake Nona Connect (LNC) is to deploy technological innovations that are driven by community need and input to 1) understand the movement of people, goods, and services, and 2) benefit the wellbeing and quality of life (QOL) of its residents.
   - The first objective is to identify the preferred methods of inclusive transportation, pain points, behavioral patterns, including pedestrian mobility. This will help to determine the effects on accessible transportation infrastructure and how to improve mobility throughout the community and surrounding areas.
   - The second objective is to improve the health and welfare of people within the community. This may include health and wellness, healthcare, human services, resiliency, safety, social services, and telecommunications.

4) **Smart Parking / Curbside Management**
   - Parking availability via ground sensors or cameras with on-camera intelligent video analytics.
   - Cameras serve dual purpose for security video and vehicle count of parking lanes, decks, on street, or lot.
   - Parking availability data can be provided to signage, backend services, and/or customer specific apps.
   - Curbside Management including delivery zone violations, ride-share pickup & drop-off, bus stop violation detection, double park violation detection, and more.
   - Dashboard for visualizing data analytics and parking space management.
   - License Plate Recognition (LPR) for access control and billing.
   - Benefits
     - Reduced vehicle traffic from drivers circling the block looking for a parking spot.
     - Improved driver experience leading to greater return customers and improved parking spot utilization rates.
     - Detection and notification of vehicle overstays.
     - Meta-data stream (object identification/classification) preserves privacy while also reducing back-end communication bandwidth requirements (on-camera edge intelligent video analytics processing compared to full video stream).

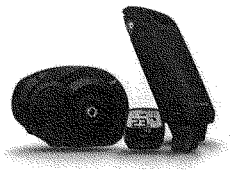


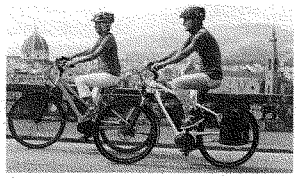
5) US-33 Ohio Smart Mobility Corridor

- Project led by Ohio DOT and DriveOhio to create a 35-mile Smart Mobility Corridor along US-33.
- Bosch is deploying pilots to demonstrate intelligent video sensing solutions along the Smart Corridor and in Marysville that have the ability to increase safety.
- Prepares Ohio roadway infrastructure for the future of connected and automated vehicles

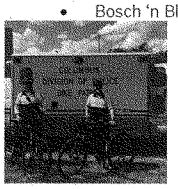
Cross Traffic Warning	Warn drivers at intersections where cross-traffic is hard to see.
Curve Speed Warning	Alert drivers approaching exit ramp at too high speed.
Pedestrian Safety	Inform connected vehicle drivers of pedestrian presence near or in the roadway.
Exit Ramp Queue Warning	Inform drivers of approaching exit ramps of queues or stopped cars.
Red Light Violation Warning	In combination of Cross-Traffic Warning, inform connected vehicle of probable violation.
Work Zone Warning	Identify late merge of distracted driver, audio and visual alerts to inform driver and workers.
Wrong Way Driver	Detect and notify drivers of hazard, track wrong driver with pan-tilt-zoom camera.

6) **Bosch eBike Systems**
   - **Pedal-assist**: Electric motor engages only when pedaling, allowing precise assisted speeds of up to 20 or 28 mph, no throttle needed and either hand is free
   - **Power and Range**: the 350-watt motor is powered by a 500 Wh lithium-ion battery for up to 100 miles per charge
   - Fast, full charging in 4.5 hours using a standard 110V wall outlet
   - Available on over 30 different bicycle brands in North America

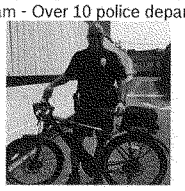




- Bosch 'n Blue Program - Over 10 police departments



Columbus, OH



Laguna Beach, CA

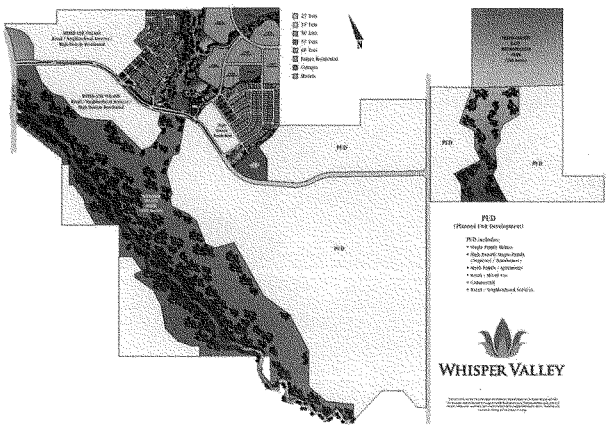
Tucson, AZ

Royal Oak, MI

Detroit, MI & Wayne State University

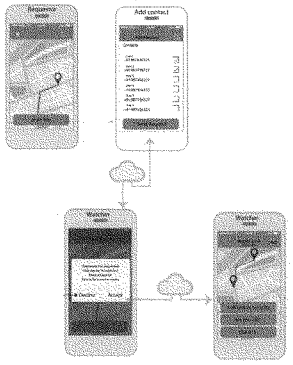
7) Whisper Valley master plan community – Austin, TX

- Partnership with Taurus Development and EcoSmart Solutions
- 2,0663-acre mixed-use planned community
- 7,500 single and multi-family homes
- Over 2.0 million square feet of retail & office space
- Focus on community scale energy efficiency
  - 100% geothermal, utilizing Bosch heat pumps and community shared geothermal loop
  - Energy efficient Bosch appliances
  - Google Fiber throughout community
  - Available solar PV to target Net-Zero capability
  - Dedicated land for on-site Farm to Table operations
  - On-site sustainable living education and community center



8) **Five Point master plan community – San Francisco, CA**
   - Partnership with Five Point developer
   - 12,000 new residences
   - 5 million square feet of commercial space
   - 350 acres of parks and green spaces
   - Security Community Portal (SCP)
     - Engagement with residents, tenants, and employees in security
     - Live streaming of camera feeds
     - Tenant incident reporting and notifications
     - Incident assignment, notifications, and tracking
     - Patrol dispatch and communication

   - Resident safety and security – "Walk Me Home" functionality.
     - User submits "Walk Me Home" request to observer (friends, family, or security provider)
     - Observer granted temporary access to movement path of requester
     - Observer alerted on:
       a) Fall detection
       b) Panic button press
       c) Unexpected stop
       d) Unexpected path change
       e) Position update omission



October 21, 2019

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Short Biography for Scott Averitt

Scott Averitt works in the corporate government affairs group for Bosch where he serves as Technical Expert and Manager focusing on advanced R&D projects, public/private partnerships, and government funded projects. He collaborates across all four of Bosch's business sectors including Mobility Solutions, Industrial Technology, Consumer Goods, and Energy and Building Technology. Scott also works in partnership with many universities, national labs, and industry members. His activities include investigation of new technologies, products, markets, system solutions, business partner development and alliances, system level concept creation, and public funding proposal generation and project support.

He holds a degree in Electrical Engineering from Lawrence Technological University in Southfield MI and he has 20+ years of experience designing and developing electronics, software, and systems across residential, commercial, industrial, and automotive applications. Scott has held many roles within Bosch over the past 16 years of employment for the company. His previous positions include Design Engineer, Senior Project Engineer, Technical Expert, and Technical Project Lead/Manager.

Chairwoman STEVENS. Excellent. Well, at this point we're going to begin our first round of questions from the Members of Congress here today. And the Chair is going to recognize herself for 5 minutes.

And thank you for this round of testimony. This is nuanced and technical, and we often say that the devil's in the details. Well, my takeaway is the devil's in the data and how we're recognizing working with the data and capturing it. And we certainly have infinite opportunity to capture data this day and age, the rate at which we are collecting, and certainly appreciate the nod to the role that this Committee plays in catalyzing and transforming technology opportunities, mobility solutions, the "if not but for" principle of where the Federal Government comes in as an effective partner.

We learned from the *FAST Act*, the most recent surface transportation law that Congress authorized funding for a number of programs focuses on improving mobility, but yet there's still some aching for R&D dollars. And I'm grateful to each one of you if you don't mind to just chime in on your view of the Federal role in supporting research and development in the deployment of smart mobility technologies across this country, particularly including small cities and communities.

And then also let's take it down just one more notch and look at how the Federal Government balances long-term research needs with short-term deployment and testing activities.

And, Mr. Coulter, if you don't mind, I'd love to start with you.

Mr. COULTER. Yes. So thank you. So, as I mentioned, in our pilot program, the traditional funding options are not sufficient to allow us to pursue it, and so, as I mentioned, either through grants and R&D at the Federal level or stricter vehicle safety mandates or whatever it takes to help to make the technology more cost-effective because the technology is there, but the cost is still a barrier. And so if we can use R&D for that or those mandates, that would be very helpful.

Chairwoman STEVENS. Unlocking barriers indeed.

Mr. COULTER. Indeed.

Chairwoman STEVENS. Mr. Dowd, I know you have some first-hand experience with——

Mr. DOWD. I do have——

Chairwoman STEVENS [continuing]. Federal R&D dollars——

Mr. DOWD. I have strong views in this space. The current rate in which communities and universities are being funded right now on mobility is not good. There was a $60 million ADS (automated driving system) grant that was put out by USDOT. It was way short in terms of the amount of money. In Texas there were two excellent applications that were submitted, no funding for Texas at all. Virginia, you got two—it's unfortunate with automation as being the forefront of where we're going that we don't have enough money in the system.

Chairwoman STEVENS. Yes. Yes.

Mr. DOWD. The National Science Foundation on the other hand has been great in terms of—they have the smart and connected communities. They have a $43 million grant program with us that's out right now to help communities and universities work together to try to solve mobility solutions.

Chairwoman STEVENS. Yes. And we here in Michigan recognize how much we are doing with so little, and we're doing it almost at the expense of not having——

Mr. DOWD. I'd like to point out, though, Detroit did win an ADS grant this year.

Chairwoman STEVENS. Yes. We'll take all the grants we can get. Go ahead, Dr. Rajkumar.

Dr. RAJKUMAR. Sure. Just part of that, the smart mobility market, if you will, is supposed to become a multitrillion dollar market in the future per year.

Chairwoman STEVENS. Yes.

Dr. RAJKUMAR With a "T", right?

Chairwoman STEVENS. Yes.

Dr. RAJKUMAR. And part of that is actually global competition with China in particular emerging as a very competitive rival. So I think in the U.S. we should continue to be investing substantial dollars above the budgets that we currently have to enable our leadership, which will also not just have a technological implication but an economic implication down the road.

Chairwoman STEVENS. Yes.

Dr. BILLS. One thing I'll say is that transportation is one of those types of services that really requires the Federal Government to lead. A lot of large-scale implementations just won't happen without the leadership and funding and support from the Federal Government.

And so I think that one important thing is to really set priorities for incorporating more smart mobility and making sure that we're doing that in such a way that the most disadvantaged communities are not left behind. So the extent that the Federal Government can serve as a catalyst for bringing together efforts from research, from industry, and from the public sector and mandating that there is clear consideration for the broadest set of transportation needs, I think that that's something that's very important for the Federal Government to lead in.

Chairwoman STEVENS. The deployment, yes. And our private sector partner, please tell us.

Mr. AVERITT. So, yes, I mean, it's actually very critical in that respect from a funding perspective. It provides an opportunity that otherwise wouldn't exist with industry. For example, we recently partnered for an ATCMTD (Advanced Transportation and Congestion Management Technologies Deployment) grant, which is the short name of what you pronounced earlier, for going along the Woodward corridor to put in pedestrian detection and those types of systems.

And those technologies exist, right, but getting them deployed out into the community and seeing how well they really work and how do they really impact the community around them, you know, it allowed us for that—we partnered with Wayne State to be able to—after the point go and take a look and see how well did it really work, to reach out to the community and see was it effective, how was it perceived, right? So beyond just deploying it, that's one thing. You actually got to make sure that it's doing what it's supposed to do, and that's where the grants really come into play in that respect.

Chairwoman STEVENS. Well, and with the remainder of my time, the elephant in the room also appears to be productivity. You know, productivity is either going to decline or increase, and inequality might rise. These technologies not only have the ability to save lives and grow our regional economy, they have the ability to create jobs. And I was just wondering if you can touch base a little bit on the economic development opportunity of smart mobility strategies.

Dr. Rajkumar, go ahead.

Dr. RAJKUMAR. The average American commutes for about 51 minutes per day to and from work, right? And most vehicles have a single passenger in them who's driving. If the vehicle can drive itself, a significant portion of those 51 minutes can be turned into productive work, so it can have a qualitative impact on productivity.

But in regard to transportation jobs, I think there's a lot of fear about driving jobs going away. Luckily, full automation is many years away, but it will happen at some point in time. If we worry about loss of jobs and not using the technology, countries like China will take on the leadership and the jobs will go away anyway, and we will have lost the technology leadership as well, right? What we need—you mentioned the technology, sustained and extended leadership and actually putting programs in place to basically retrain workers to help them garner even higher-paying jobs fixing these higher tech systems and maintaining those systems.

Chairwoman STEVENS. Mr. Dowd, did you want to chime in?

Mr. DOWD. Sure. Again, getting back to the ability for the Federal Government to provide that seed money to create jobs is a critical part, particularly in transportation. We have such an impressive transportation sector, but we aren't always on the forefront of developing what those new technologies are. If we had more grant money along that way, I think that we could create jobs around these spaces.

Chairwoman STEVENS. Yes. Well, it's certainly something we here in Michigan know very well. And one of the joys of my job is boasting about my region and the rate at which we are proliferating technologies and innovations that scale and the jobs that depend on it, but they need to be deployed. And it can't just be, to Dr. Bills' point, for one community over another. It needs to be equitable, so with that, I'm going to yield back the remainder of my time and recognize my colleague from Texas, Mr. Cloud, for 5 minutes of questioning.

Mr. CLOUD. Well, thank you Chairwoman Stevens. Again, it's really great to be here. I am from the Gulf Coast of Texas. My district includes Corpus Christi. I live in the town of Victoria that's a little smaller than this, and then the rest of it's agriculture. And so it's a pretty interesting and diverse district.

I have to say driving in here it was nice to see colored leaves on the trees, so I appreciate the Midwest in the fall. It's a nice treat. We don't get that very often in south Texas, we have about 2 weeks of winter.

Mr. FOSTER. Will the gentleman yield? Do you have trees at all in southeast——

Mr. CLOUD. We do have trees. They go from green to no leaves in 2 weeks and then start over. But yes, it's really good to be here. I appreciate it.

Dr. Rajkumar, I want to start with you. I understand that a team from Metro21 worked with the Department of Energy to examine how communities in southwestern Pennsylvania can utilize these modern innovations in transportation to improve rural mobility. That's extremely important where I come from. Could you talk a little bit about your work and how the lessons learned from that research could be used in developing modern rural mobility plans across the country?

Dr. RAJKUMAR. Very early in that particular process, several factoids. Greene County that we are working with is probably the poorest county in Pennsylvania, part of the tri-State region. Luckily, they actually have a home university called Waynesburg University, which is located there, as being a huge educational force if you will for the local population so I guess, unfortunately, it's very rural, economically not doing well, but we actually have this brain fuel right at the center. So we are working very closely with the President of Waynesburg University to brainstorm and discuss educational programs, number one; number two, try to define innovation projects if you will that they can start engaging the community in.

So we're looking at multiple aspects if you will, looking at how we can bring to bear public transit aspects, subsidize ridesharing, micro-transit, looking at AV shuttles if you will, looking at whether we can bring in electrification of vehicles into the picture and so on. So all of this is ongoing.

So forming relationships between faculty of both universities, engage with communities in both locations and see what technologies can be applied. We think incentives would make a big difference and policies would make a difference.

Mr. CLOUD. OK. Anyone else have examples of projects that are being implemented in rural communities specifically or some successes maybe that we're making, where we are in advancing projects in——

Dr. RAJKUMAR. It is a challenge in the following sense. I like to draw the analogy with going back to the 1930s when electrification of rural communities was happening. The private energy companies were not interested in basically deploying electrification because the population was sparse and the expenses were heavy.

Mr. CLOUD. Right.

Dr. RAJKUMAR. So basically we had to revisit some of the experiences of the past and try to repeat it for technology and mobility as well.

Mr. CLOUD. OK. Our district, too, is an export district, so we have energy assets, and then we have farming communities. Everyone's trying to get their products, so freight becomes a big deal. Could you speak to any developments that are happening along the lines of freight transportation, what can we do to help promote the development of these technologies as it regards to trade in——

Dr. RAJKUMAR. So automation of freight vehicles of course would be a big application that can drive this forward. Driving on highways actually turns out to be a very monotonous job if you will,

and then the truck drivers basically have to travel very far from their homes for long distances, and they are limited to driving 11 hours a day.

In terms of the vehicle that can drive itself, it can drive 23 hours a day, right, and be safer as well. And that in turn can actually be coupled with humans actually driving in urban contexts and dense contexts and so on, so I think that technology frontier I think needs further investments.

Mr. CLOUD. Anyone else want——

Mr. DOWD. So I would——

Mr. CLOUD. Yes.

Mr. DOWD [continuing]. Just like to echo the fact that automation—often we talk about moving people, but because of the way that it's not developing as quick as everybody thought it would be, but in terms of moving goods, it is actually much more capable because there's less opportunity for people to get hurt. So that's a space where additional investment would be very helpful.

Mr. AVERITT. There's also the possibility with automation to shift driving of freight to off-hours so that you're not, you know, in the middle of traffic jams and things of that nature, so you can actually better manage your infrastructure and you're not jamming it up with a bunch of freight in the middle of the day. Those are——

Mr. CLOUD. That's a good point. Any other thoughts?

Mr. AVERITT. The other thing—we have this project that we've got with Ohio Department of Transportation, which I mentioned in my testimony that's looking at truck platooning. And it's mostly looking at like driver-assistance features, right? Again, how do you make it easier for those 11 hours a day so that the truck driver is not, you know, having issues with that or they've got a little bit of an easier job. That's one of the things.

The other thing is like I mentioned about doing 24 hours and stuff of that nature where you can actually still have a driver in the truck, but they're following behind other ones so that when they get off the freeway, they can manage from that location. So there's lots of different things you can do in automation with trucking to really get you to those points.

Dr. RAJKUMAR. Technology could also help in pooling to get the demand from multiple smaller producers if you will, that if they're able to get together to a virtual market if you will, they can pool their demand and basically one freight vehicle can actually supplement all those demands, so it's basically about pooling of your shipping requirements.

Mr. CLOUD. Right. Right.

Mr. DOWD. I also would like to point out that in rural communities there is a spatial mismatch oftentimes between where people live and where things are, right? And so drone delivery is currently not—you can't realize it the way it should be realized right now because of FAA (Federal Aviation Administration) regulations, but the ability to get medication to people in rural places could—be able to get them even doctor's care through the doctor—basically bringing the camera to the people and having them have—so there are many opportunities to be able to explore some of those opportunities that hasn't been fully realized yet.

Mr. CLOUD. Yes, thank you. I have a lot more, but my——

Chairwoman STEVENS. Yes, excellent.

Mr. CLOUD [continuing]. Time's up, so——

Chairwoman STEVENS. Excellent. But the Chair will now recognize Mr. Foster for 5 minutes of questions.

Mr. FOSTER. Thank you, Chairwoman. And I want to thank you for having this hearing.

You know, I'm Congressman Bill Foster. I represent the 11th District of Illinois in the suburbs of Chicago. I sometimes introduce myself as saying I represent 100 percent of the strategic reserve of physicists in the U.S. Congress. I'm the only Ph.D. physicist in the place.

I'm also a manufacturer. When I was 19 years old, my little brother and I started a company in our basement that now manufactures about 70 percent of the theater lighting equipment in the United States. And so we do hardware, software, you know, sheet metal painting, and we've kept all those manufacturing jobs in the Midwest, which is something I'm really proud of.

And so I'd like to, you know, congratulate Chairwoman Stevens again for having this hearing really in the heart of auto component manufacturing because when the revolutions that we're seeing and we're going to be seeing in automotive are going to have a big impact on the parts that go into cars, and so it's really appropriate and good that the technology is talked about and developed so close to the manufacturing centers here.

Now, my question really has to do with the timescales. There's sort of three simultaneous revolutions we're talking about. There's electric cars and trucks, there is self-driving cars and trucks, and then there's smart roadways and infrastructure. And so if the panel could just sort of comment on when they see, say, the 50 percent adoption point for each of those, for both cars and trucks and it's those three technologies: Electric, self-driving, and then smart roadways.

Dr. RAJKUMAR. Sure. I guess if you look at the numbers, Congressman Foster, we have 350 million registered cars in the U.S. today, and we sell about 80 million cars, right, in a very good year, right? So basically then the average age of a vehicle registered is about 11 years. If you do the math, if all the vehicles are being sold every year become automated, connected, electric, it would still take about 15 years, right? Of course, it's going to be a long time before all the vehicles being sold in a given year has those capabilities, so we are talking about at least a few decades for us to reach a 50 percent threshold if you will.

Mr. FOSTER. So there's a difference—there's 50 percent of new cars being manufactured, which will happen much before——

Dr. RAJKUMAR. Right.

Mr. FOSTER [continuing]. The 50 percent of the cars on the road, and so I was more interested in where we hit the 50 percent of cars being manufactured——

Dr. RAJKUMAR. Oh, sure.

Mr. FOSTER [continuing]. Say, electric——

Dr. RAJKUMAR. Yes.

Mr. FOSTER [continuing]. Self-driving——

Dr. RAJKUMAR. Yes.

Mr. FOSTER [continuing]. Or so on.

Dr. RAJKUMAR. So studies indicate that if—even about 8 percent of the vehicles on the road basically have these safety features, the connectivity features, that's actually a very big positive impact if you will. So basically really if you do the numbers in terms of that, the next 10 years or so we will likely reach that 8 percent, 50 percent threshold within the next decade.

Mr. FOSTER. All right. Other comments or estimates on that on—Mr. Averitt?

Mr. AVERITT. In terms of time, I couldn't say. I can tell you one of the things that in order to get there is we need to get to cost neutrality with existing vehicles, right? It's one thing to, you know, have the technologies available and on the market. It's another thing for it to be affordable, and those are things that we're striving for with the OEMs (original equipment manufacturers), be able to get those prices down where it's, again, cost-competitive with existing technologies on the road.

So that's something that it's a few years out at least before you get to that point. There's a lot of work going in R&D to get to those points, especially in battery research and electrification. There's a lot of other research going on in the areas of automated vehicles. But it's still early yet for those things. There's a lot of extra hardware and sensors and so forth that need to be added to a vehicle to make that happen, so it's a few years off before we get to neutrality.

Mr. DOWD. I would also like to—on automation I think maybe you were thinking about things linearly, right? You know, when is that 50 percent going to hit when automation may actually come to us in a different way. The idea that we'll have car lots with automated cars I think is less likely than us changing our mobility choices to include automated transportation. So it's not that you're going to go buy an automated car, but you can actually use an automated car. So I don't think—the 50 percent piece may not really actually be applicable in that space. I think we'll actually be changing a little bit of how we consume cars.

Mr. FOSTER. Well, I was just struck by—I believe that Tesla is claiming they're going to deliver full autonomy next year, OK, there's a pretty wide spread in opinions on when this might actually happen. And it must matter tremendously to industry trying to plan for the transition——

Mr. DOWD. What's fascinating, though, is that the other automated car companies aren't even close to that, so is it that Tesla is so far advanced and so far beyond Waymo and Cruise and like—is that the case, or is it that they define automation differently? So if Google Waymo is out there still testing their cars in Arizona because it's flat and it's dry, they haven't quite gotten to Michigan yet or—you know, how is that possible that Tesla is able to magically come up with an automated car?

Mr. FOSTER. Well, I guess time will—yes.

Dr. BILLS. So I unfortunately don't have an exact answer to the 50 percent market penetration question, but one thing I think it's tied to is, you know, the network of places where people might refuel. And so we have this, you know, rich network of fuel stations for gasoline. We don't see many fueling stations for electrical vehicles. And so, you know, the extent to which that becomes more of

a publicly aware or incentivized thing on the business side, I think that we'll see a lot more people seeing the benefits of electrical vehicles and seeing it as a real option for them and purchasing. So that's what I want to add.

Mr. FOSTER. Yes, and I have to say that from my time living in Ypsilanti, I had this nightmare of what happens at a University of Michigan football game when 100,000 people drive in, discharge their batteries, then the game's over and they all have to find a charging station.

Mr. AVERITT. To that point, just some quick math, 1 percent—if you take a million electric vehicles and you put them on the grid to charge, it's about 2 percent of our grid's capacity. Now you do that at 10 million vehicles, now you're at 20 percent. You get to the 450 million, and, yes, they're not all charging the same time, but you've quickly exceeded the grid's capacity very easily. So there's a lot that has to be done on both sides of it. It can't just be the vehicle side of it. You actually have to do a lot on the grid side as well.

Mr. FOSTER. Yes. Would you anticipate they'll be around when you have self-driving internal combustion cars and trucks as a significant component just because of the difficulties in getting the electric infrastructure?

Mr. AVERITT. I think there's going to be a mix. I think one of the things we've seen is that a lot of things is they're rolling out new technologies. They tend to roll out the newest stuff on the latest vehicles, right? So a lot of the fully automated stuff will wind up on the higher-end electric vehicles at the very beginning as they deploy technologies. Again, as it matures and as the costs come down, you'll start to see it more on mainstream vehicles.

But there is the point that Bill brought up about there is the possibility there's a massive shift in the way we have vehicle ownership, right, in terms of, you know, where we have that 450 million or if you have a lot of automated vehicles, is it a matter of, you know, you click a button on your smartphone and it just comes pick you up and you go where you need to be and you don't actually own the car anymore. And that might change the ownership model dramatically, as well as the need for how many would charge and so forth. So there's a lot of things that are being looked at by industry as well.

Dr. RAJKUMAR. Electrical vehicles do have fewer moving parts, and the cost of batteries is dropping significantly. At some point it would not make economic sense to basically buy an internal combustion engine car. So the transformation could be abrupt.

Mr. FOSTER. Yes. Now, I've seen—someone says—some others 2 or—2 to 3 years with a crossover—with a total cost of ownership will be lower for an electric car——

Mr. AVERITT. That——

Mr. FOSTER [continuing]. Because batteries are just dropping like——

Mr. AVERITT. Yes.

Mr. FOSTER [continuing]. A rock.

Mr. AVERITT. That's very much the case, yes.

Mr. FOSTER. All right. I yield back.

Chairwoman STEVENS. Thank you. We are going to do one more round of questions, so the Chair is going to recognize herself for another round of questions. And actually just picking back up on that, you know, we just talked about the need to invest in the R&D and how we define deployment and the role that the government plays in helping us hit some of these goals. You know, the question is, is this all incumbent on industry to hit the electric vehicle considerations. We're working on the electric vehicle tax credit up from 200,000 vehicles per year to 600,000, recognizing that that also helps us hit sustainability goals as far as where industry is moving.

And, Mr. Coulter, I'd like to ask you because you tend to have some really great examples of public-private partnerships and models that are working at the county level in one of Michigan's largest counties, so I'd love for you to kind of chime in on ways in which government, be it, you know, at the county level maybe reaching for Federal or State Government in partnership with industry.

Mr. COULTER. Yes, it's true. We're very active in that space. The one piece that strikes me because I believe it was Raj who mentioned the talent pipeline, and that's something that we're really concerned about in Oakland County, making sure that we have, you know, the workforce that's going to be able to deploy this technology and do this. And we've been partnering with Lawrence Technological University and Oakland University, but I think that's a bigger issue than a local government can manage, and so making sure that we have the talent to be able to bring this to market is going to be really critical for us.

Chairwoman STEVENS. I'm looking at Dr. Bills because it's becoming a chicken-and-egg question——

Dr. BILLS. It is.

Chairwoman STEVENS [continuing]. Around equity and, you know, accessing jobs and then being able to do the job. And if it's transportation, accessibility, and throughout that spectrum.

Dr. BILLS. Absolutely. I mean, you know, mobility is a huge issue for a lot of people, so there are many residents in the area who really struggle to access the opportunities that are available. And we have public transportation, but they are still not quite providing the level of coverage and the level of reliability that is required to maintain employment and maintain visits to healthcare facilities, which obviously has implications in terms of healthcare outcomes and the ability to contribute to the economy.

And as you mentioned, there's a real chicken-and-egg sort of dynamic going on here where we're trying to provide people with the services so that they can reach opportunities, and we're trying to do that in a way that leverages the technologies that are coming online. And yes, so that's one of the——

Chairwoman STEVENS. Well, and it's going to be intentional development of the strategies, and that's I think, again, in part to a nod to our audience and the extensive outreach that we did for today's hearing, right? This is about establishing legislation, enhancing legislation for the best outcomes for our country and obviously for our community. And you've got to have all stakeholders to the table while you're doing it. You can't just add them in down the road.

This is, again, Mr. Dowd, things that you worked on when you were serving in the Obama Administration and bringing, you know, partnerships together. It didn't all just come at the end when the money was awarded as, you know, on the smart cities projects. It's got to be a part of applications. It's got to be a part of the approaches.

And with my remaining time, Mr. Averitt, you mentioned in your testimony—you talked about this, how Bosch is deploying video and sensor, you know, solutions to increase pedestrian and vehicle safety. Could you just elaborate on Bosch's privacy and cybersecurity plan for deployment of this technology? Also kind of hanging above this conversation on smart mobility, the big question that everyone likes to ask is, what are the cybersecurity implications of this, and can we hack cars and hack into consumer activity?

Mr. AVERITT. Yes, certainly, and that's one of the very key points about those technologies is that, again, you know, with these things, we've got connected vehicles as well, right? It's great if it's connected, you can do all this stuff, but if somebody else can track it in a nefarious way, that's not a good thing, right? So there's a lot of things you've got to do from a cybersecurity and a privacy perspective.

So when it comes to the video as a sensor, one of the things that we do is we decouple the video feed from what we would consider the data stream or the object identification, so there's a separate data stream that comes out, that that's what you use in the intelligent transportation system, so it says there's an object here, there's a car, there's a pedestrian, there's a cyclist. There's no identification of the person, there's no facial recognition, there's no image of the face whatsoever. It's just there's a person and that they're there or how many of them are there or they're in the cross-section, you know, there's this many vehicles at an intersection. So it's very much decoupled from, you know, what you would think of video cameras doing, right?

And then everything else from that side in terms of the actual video stream, those are accessible for, you know, police and fire to be able to do post-accident investigation or, you know, something of that nature, but those are all, you know, kept behind firewalls. They're all part of the networks that have put in place, and there's very high levels of cybersecurity and other information that tries to keep that protected.

Obviously, that's an ever-changing thing, so you always have to make it updatable and fixable so that you continue to morph with the threats that are out there, so that's something that we do continuously.

Chairwoman STEVENS. Yes. Dr. Rajkumar?

Dr. RAJKUMAR. Two points. The car makers are very sensitive to this need for cybersecurity, so they anticipate needing to spend extra time and effort on basically making sure that these vehicles are secure. They did not have to do that before. They did not worry about it before, but now they are.

Second, this is really a pre-competitive issue if you will, so they're absolutely working with each other to make sure that they

understand the best technologies out there so that all these technologies are secure.

Chairwoman STEVENS. Yes. And I think it's also about defining it for the public, and that's part of the Committee's responsibility as we talk about definitions, you know, how do we define autonomous vehicles, how do we define cybersecurity standards. We have oversight of the National Science Foundation, as well as the National Institute of Standards and Technologies, and these standards become imperative for us as we move forward and, you know, and again the plight for data but data at what cost and for what outcome, you know, certainly one of the means to the end but the empirical experience also moves us forward.

I'm out of time, so I'm going to yield back and now recognize my colleague from Texas again for another round of questions.

Mr. CLOUD. Thank you. This is a great conversation, and I have enough questions we could probably go on for a few more hours.

But I'm trying to put this into context of what we're going to have to deal with. We're in a competitive environment. You mentioned the global competitive environment. Could you all speak to the context of where we are in relation to other countries in developing these? I know there's some very specific challenges in the sense of we care about data security and especially privacy in a way that some of our competing countries, they can mass collect and force collect data on every individual, and when it comes to developing these technologies, machine learning, AI, and how that all integrates into this picture.

And then speak to how the phases you see us walking through, I guess, from a technological engineering standpoint. Mr. Dowd, you commented on how the FAA regulations are more what's holding up as much as Congress can sometimes move slow. I don't know if you all have heard that before.

Mr. FOSTER. Just the Senate, just the Senate.

Mr. CLOUD. Just the Senate. Unanimous——

Mr. FOSTER. Or at least two out of three——

Chairwoman STEVENS. Yes, we don't like——

Mr. CLOUD. So, you know, one of the things I think we're trying to keep in mind as policy is to make sure that the legislative path keeps up with the engineering science track that's happening in the sense of, OK, what's the outlook for the next phases of development, but then, legislatively, what's the next legislative phase of development that needs to happen, maybe regulations that are in the way that need to be looked at, the next steps of laws, you know, just what's the track forward for that in your mind?

Dr. RAJKUMAR. If I may, Congressman Cloud, it's a huge market, multitrillion dollars per year in the smart mobility space. The technology for our automated vehicles, and connectivity if you will was literally born in the U.S., and so we started out as leaders. It's not going to be an easy task maintaining that leadership or extending that leadership would require substantial investments, I believe, if we're going back to the areas that we discussed earlier. A lot more money needs to be invested in. To build us a huge market, we need to continue to maintain that leadership.

It has become a global race. It's not just the U.S. in the race. It's Europe, or Germany in particular, and then in Asia it's actually

China, Japan, and Korea if you will. So it's a global competition. We need to be investing resources now to keep things moving forward in our country.

The regulatory aspect I think is a very sensitive topic if you will. Regulations may be needed, but if we overregulate compared to other countries where the regulation is less, they may actually end up taking leadership where they're able to test things on their own very quickly and then get that technology to mature.

That being said, I think our local companies need to basically have responsibility, so while it needs to be regulated, I do believe that it needs to be regulated lightly to ensure that the companies are acting responsibly.

I guess in the United States I think they're doing pretty well in terms of the technologies inside the vehicle, but what's happening, infrastructure—I'm actually afraid that we may be lagging a bit. There's a lot of, I guess, controversy if you will in terms of infrastructure investments and the frequency spectrum allocation and such if you will. And I'm afraid that at this point in time China has basically picked a horse to bet on, and they're actually going forward very strongly, so we need to be very sensitive to that particular dimension of connectivity. So I'm just worried on that front.

Mr. AVERITT. As a global supplier for these technologies, we are implementing them across the world, right, in all the countries around the world. I wouldn't say that anyone of them has more deployments than another at this point. I think one point that I could mention is that being a global company we can put our centers of competency anywhere, right, but we have a very large presence here in metro Detroit area. We also have a very large presence now near Carnegie Mellon for our Bosch artificial intelligence, and that's primarily because that's where the talent is coming from, right? It's coming out of the universities, and that's a big factor in developing and deploying these technologies is we need engineers. We need software engineers. The last numbers I heard is there's something like a couple hundred thousand open software positions in this country, and we just simply can't find enough to fill those voids. It's a major hurdle toward, you know, getting to the next level of these technologies.

Mr. DOWD. I would like to just build on—the university system is by far one of our best assets in this——

Mr. CLOUD. Yes.

Mr. DOWD [continuing]. In this race. And the ability for universities to work with companies and universities working with communities is where I would push. So there is—the partnership between universities and—like Metro21, the university and the city allows both the city to increase its capacity and allows the university to have a living lab to be able to test out different technologies. And being able to see that type of—with, you know, National Science Foundation, DOT, DOE, DHS all have those types of programs, and being able to get them to try to work better together would be one suggestion I would have is that they all work independently.

I personally am trying to get them to work together, all three, DOE, DHS (Department of Homeland Security), and DOT, but it's hard. And it's hard because they just don't do that well. So from

a congressional perspective, that would be one suggestion. Like FAA should be working very closely with DHS on drones. And, you can give multiple examples of how this can be done better.

The second thing is I think that from a regulatory perspective on automated vehicles, we're in a weird space. It's a weird space. You look at Texas versus California in terms of how those two States regulate automated vehicles. You look at the way that the Department of Transportation is putting out their guidance, and it gets to be a confusing space. And I think if there was some clarity in that space, that would be very helpful.

Last, on the ADS piece—I'm just going to hit that again—$60 million was a drop in the bucket to what the DOT should be doing in terms of trying to drive that because, again, that's universities and communities working together to try to get that grant money.

Dr. BILLS. I want to bring up the topic of micro-transit. This is a type of smart mobility technology that is a mixture between traditional bus transit and your Ubers and your Lyfts. It's more of an on-demand service, and it helps for providing greater accessibility to areas that don't have very dense transit networks. This is a type of mobility service that we see more prevalent abroad than we do in the United States.

We have had efforts here by industry, so we've had Ford's Chariot, we've had BRIDGE. A lot of these have gone away, but they still exist in other countries, in the U.K., in China. And I think that one of the major issues with it being successful here in the United States is that we haven't gotten the right cost structure together. A lot of the efforts that we do see that are collaborations between the public sector and pilots and things like that, they have largely just been funded, and the costs are paid for and this is piloted out to the community, but we haven't looked at how we come up with a cost structure to make this more sustainable. How do we come up with the right mix of city and county and government incentives and farebox contributions to make this type of transit work? We know that it will provide for greater accessibility in areas that don't have heavy public transportation investment. And so this is one of the things that I would highlight is that we need to focus on how we can make these more sustainable from a cost perspective.

Chairwoman STEVENS. Great. All right. Dr. Foster?

Yes. Dr. Foster.

Mr. FOSTER. Well, thank you. Dr. Bills, I'd like to pick up on that point. You know, there are a variety of ways in which we try to provide assistance to under-resourced communities, you know, housing assistance, food assistance, and transportation assistance seems like a real possibility here, you know? The dream that there will be transportation as a service, where you just have essentially automated Ubers. And when you think about the $27 that it cost Mr. Dowd to come here, probably more than half of that was labor that will disappear. The capital costs of an automated Uber will be amortized much more quickly because it's used a much higher fraction of the time than a normal car. You know, the expense of computers will be used most hours of the day.

And so I was wondering in terms of the research that you're doing there's a lot of information that might be gleaned when you

see Lyft and Uber competing with each other raising and lowering costs. And you can see that the market responds pretty quickly to the uptake when they change their prices. So you might be able to get a lot of information on how under-resourced communities start using ridesharing services as a function of price, and then understand a significant subsidy to those prices so that if you had access to automated Ubers, say, with a 50 percent or a 75 percent discount if you were a member of an under-resourced community, that could be a very effective way of delivering assistance in the community that would offer real economic help, as well as access to jobs, which is the key long-term thing.

People use the big data sets from—that Uber and Lyft must have internally to look at how different communities use these services as a function of the price they charge?

Dr. BILLS. So there is a lot of promise there with regard to leveraging big data to understand travel behavior and therefore target communities in order to provide services that fit their needs. The challenge is—and this is based on the research that we're doing in Benton Harbor. Benton Harbor is a small city on the western coast of Michigan. And there are a lot of people who really struggle to access job opportunities in the area. They're transit-dependent. There are large percentages of the community that don't have automobiles accessible in the household, and so they are really dependent on transit. And the extent to which that we can improve transit to provide more coverage by leveraging smart mobility technologies will provide real returns to these communities.

One of the barriers, however—and this is something that—I think that we know but we tend to forget is that, there are many people for who the digital divide is still present. They might have a smartphone, but it's not up to date. They are not positioned well to download an application and use it to call a Lyft or an Uber to take them, and so, you know, we've done a lot of outreach and interfacing with these community members. And it takes a lot of orchestration to get them to participate in generating this type of data. So there is a question of how well we're representing these communities because they are not contributing to the big data at the same rates that others might be.

And so that's one thing to remember is that, you know, we do need to think about how well we can capture their needs given the existing ways that we're collecting data. It is true that we are in a position to provide real benefits to the community members, but we have to figure out smarter ways to make sure that we're capturing their needs.

Mr. FOSTER. Yes, because I think everyone is worried that technology is going to drive even more inequality in wealth. You know, the potential loss of jobs and——

Dr. BILLS. Yes, that they will be left behind.

Mr. FOSTER [continuing]. Most skilled—right.

Dr. BILLS. Yes.

Mr. FOSTER. But on the other hand, there's this incredible observation that if you're a billionaire, you cannot get a better smartphone, which is probably the most important device in our lives. And just that simple fact means that there's a lot of equality that's being driven by technology, and transportation as a service

delivered at very low cost to everyone would be a tremendous equalizer——

Dr. BILLS. Absolutely. Absolutely.

Mr. FOSTER [continuing]. In our economic life. So I think this is a real source of encouragement for me and I want to——

Mr. DOWD. Can I——

Mr. FOSTER. Yes.

Mr. DOWD [continuing]. Just try to give you a little bit more encouragement? So the community of practice that we talked about with the Texas Innovation Alliance and Smart Cities Lab, are 20 cities, we found something fascinating, which is that access to nonemergent medical care, right, trying to get people to the doctor was a significant problem because of cost, that they couldn't get there. Either that, or they had to take two buses, et cetera.

And what we found in almost every one of the communities that we worked with, the public health folks were stepping in. They were stepping in and getting their own programs with Lyft and subsidizing the Lyft and not necessarily Uber. They found Uber difficult to work with. But——

Mr. FOSTER. Geez, I wonder why. OK.

Mr. DOWD. But with Lyft in a lot of the communities with the public health folks that's exactly what was happening. They have this little nascent incubating opportunity to get people to nonemergent medical care using Lyft on a subsidized basis.

Mr. FOSTER. Right. And you can imagine even from the point of view of getting people to jobs, you know, if you had effectively access to free or very low-cost transportation on demand, it could be transformative to the economic opportunity of people.

And so last question. What is the guess for how much cheaper the Uber ride will get when you go to full autonomy? Is that going to be a factor of two?

Dr. RAJKUMAR. I guess the basic math is that roughly 75 cents of every dollar that you pay Uber and Lyft goes back to the human driver, right? And then I guess in principle the vehicle can drive itself, that 75 cents stays with the company, right? So if—I guess——

Mr. FOSTER. Well, then they'll compete and they'll lower—and they'll stay with the consumer?

Dr. RAJKUMAR. So the lower part would basically be 25 percent.

Mr. FOSTER. So there could be a factor of four reduction in——

Dr. RAJKUMAR. A factor of four, but you have to worry about the initial investment basically is much higher, it needs to be maintained, needs to be delivered, needs to be picked up, and so on, so I think a factor of four is something that we can look at, but some people likely debate whether it'll be that high or not.

Mr. FOSTER. Yes. But that's really promising because that means a relatively small subsidy can get someone to a job where then the job that they—you know, they'll end up paying more taxes than the subsidy—the value of the subsidy.

Dr. RAJKUMAR. And we could even start with a very focused initial program where if somebody cannot have access to transportation to get to a job interview, they aren't going to get the job, right?

Mr. FOSTER. Yes.

Dr. RAJKUMAR. So even if we can just subsidize that first interview step, after that they start making money if you will. So it could be very targeted. We actually have a program at Carnegie Mellon that we basically had a foundation fund, a pot of money with which we generate coupons that we actually hand out to people in rural or suburban communities if you will that they can use to pay Uber.

Mr. FOSTER. Yes. And you don't have to wait for the technology——

Dr. RAJKUMAR. Correct.

Mr. FOSTER [continuing]. To do that experiment——

Dr. RAJKUMAR. Correct.

Mr. FOSTER [continuing]. Because a human Uber is just as effective——

Dr. RAJKUMAR. Correct.

Mr. FOSTER [continuing]. As a—well, I just—now I have to personally jump on an airplane, but I just want to thank the——

Chairwoman STEVENS. Not an Uber.

Mr. FOSTER [continuing]. Chairwoman again for having this hearing. It's—you know, it's—it really highlights the—you know, everything we're talking about is downstream of decades of Federal investment.

And, you know, the DARPA (Defense Advanced Research Projects Agency) challenge that proved you could make self-driving cars—you know, I represent Argonne National Laboratories where all of the lithium ion batteries in cars use cathode components developed, you know, more than a decade ago at Argonne National Lab. And it just goes on and on and on.

And I just think one of the great things about this hearing, it should highlight the crucial role in Federal investment in the technology that shows up in, you know, the thousands and tens of thousands of jobs made right here.

Dr. RAJKUMAR. Yes.

Mr. FOSTER. So——

Chairwoman STEVENS. Thank you.

Mr. FOSTER [continuing]. Thank you again.

Chairwoman STEVENS. Thank you, Dr. Foster.

Well, before we bring the hearing to a close, I certainly want to thank our witnesses and our audience for participating and coming to today's hearing. It's certainly going to be a marker for us going forward. And it was significant to have those in Livonia, Michigan, and in southeastern Michigan, and we thank all of you for joining.

The record will remain open for 2 weeks for additional statements from Members or for additional questions that the Committee may ask of the witnesses.

And at this time our witnesses are excused, and the hearing is now adjourned.

[Whereupon, at 11:34 a.m., the Subcommittee was adjourned.]

Appendix

Additional Material for the Record

LETTERS SUBMITTED BY REPRESENTATIVE HALEY STEVENS

Christopher Andrews
Director of Mobility & Innovation
52900 Grand River Ave., New Hudson, MI 48165
Tel-248-278-5193 candrews@prattmiller.com

May 14, 2019

Congresswoman Haley Stevens MI-11
37695 Pembroke
Livonia, MI 48152
734-853-3046

LETTER OF SUPPORT
House Science, Space & Technology Hearing

Dear Congresswomen Stevens,

On behalf of Pratt & Miller, I wish to express our strong support for Congresswomen Haley Stevens chairing the hearing of the House Committee on Science, Space & Technology regarding Smart Transportation and Mobility in Suburban Communities.

As Pratt & Miller Mobility is at the forefront of research and development of new mobility solutions for all Americans, we feel strongly that smart technology, both on the vehicle side and infrastructure side can not only improve transportation choices but also save lives. We welcome the Congresswomen's efforts to gather feedback from diverse communities, consider best practices for integration of this community input and consideration of unique community needs.

Our Pratt & Miller Mobility team has been engaged in many forms of development in the area of new mobility solutions with many types of collaborations, including between public, private and academic stakeholders. Our most recent active program is providing electric autonomous vehicles with accessibility for people with disabilities on the campus of Western Michigan University through the MDOT/Plant M Michigan Mobility Challenge. We also have applied for a US DOT BUILD Grant that would provide electric autonomous vehicles with accessibility for people with disabilities in the greater Grand Rapids Michigan area.

If you have any questions, please contact me at my information below.

Sincerely,

Christopher Andrews

Director of Mobility and Innovation
Business Development
d: 248.278.5193 | m: 313.300.1259 | prattmiller.com
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REVOLUTIONIZING THE WAY THE WORLD MOVES ™

PRATT MILLER
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Curt Magleby
Vice President
Government Affairs

Ford Motor Company
801 Pennsylvania Avenue, Suite 400
Washington, DC, 20004

October 22, 2019

The Honorable Haley Stevens
Chairwoman
U.S. House Subcommittee on Research and Technology
Washington, D.C. 20515

Dear Chairwoman Stevens,

On behalf of Ford Motor Company, I want to thank you and the Subcommittee on Research and Technology under the House Science, Space & Technology committee for exploring the use of smart technology to provide small towns and suburban communities with safe and efficient mobility solutions. I would like to provide this letter of support from Ford on your subcommittee's hearing entitled, "Smart Transportation and Mobility in Suburban Communities" to help make our cities safer, more livable, and more accessible.

At Ford, we believe in driving human progress by providing greater mobility and accessibility for all. Today, we are working with cities to bring that freedom to their residents, and we are collaborating with city leaders, businesses, transportation experts and commuters to create a smarter mobility system built on new technology and data tailored to individual cities.

Ford is working with cities to help transform people's lives in meaningful ways. This includes exploring how autonomous technology can be part of an urban transportation network and weave together different transit operations to create a better system for all. Ford is piloting tools that help cities easily visualize and understand their transportation systems and the impact of smart transport solutions. As an example, Ford collaborated with the City of Ann Arbor, Michigan to pilot our Ford City Insights Platform. This platform consists of a suite of advanced software tools that allows cities to explore and help solve a variety of mobility issues, such as parking, commuter trends, transit ridership and micromobility usage, in a dynamic way not offered before. Today, following successful tests with Ann Arbor, we are expanding the pilot of these tools to more U.S. cities, including Austin, Indianapolis, Pittsburgh and Detroit.

Another feature of our work with communities includes enhancing transportation safety. Safety is a top priority for many communities, especially as crashes with pedestrians increase despite increased city infrastructure and vehicles safety measures. Using the Safety Insights tool in the Ford City Insights Platform, cities can combine crash data from police reports and other sources with our connected vehicle data to help identify locations with a high likelihood of accidents. And since not every dangerous encounter or near-miss is documented by a police report, our platform helps give planners the ability to see a more complete picture of road safety.

The unique addition of connected vehicle data gives planners insight into driver behavior (aggregated and anonymized) such as where people are hitting the brakes harshly or accelerating unexpectedly — that could mark dangerous intersections or roads. Planners can use this additional insight to decide where to focus their efforts as they work to improve safety.

To really bring all this data to life for our partners, we developed the City Insights Studio — a digital tabletop model of Ann Arbor built across six LCD screens and complete with miniature, 3D-printed buildings. This interactive tabletop offers a dynamic way to visualize information that may not jump out at you from a spreadsheet, such as transit accessibility by neighborhood. It can also display analytical insights and run simulations from all the various datasets a community has. By bringing all this data into a single physical space, we can offer local officials across departments a new and holistic way of looking at how their city moves.

As we work with communities to understand their new technology and fast-paced data needs, it is important that we consider individual community needs and recognize opportunities on how this technology might be accessible to diverse municipalities. At Ford, we do this by immersing our team in a local community through our City:One Challenge. If we fix transportation problems for one person, we can identify and solve larger problems that affect the entire city to create greater access for everyone. Our unique community-centered process blends community engagement, data analytics and iterative co-creation to "bring humanity to mobility," to assist the community in designing solutions for their neighbor, the woman on the bus, or the man they always see at the grocery store. Each City:One Challenge includes five phases that take approximately eight months to complete, culminating in a final idea that is awarded funds to implement. This process works to ensure that as mobility options are brought into a community, they reflect the needs, values and character of the community.

At Ford, we have been working hard to democratize transport for more than a century. We are now seizing the opportunity to help harmonize city transportation systems to create a more effective and efficient network that goes beyond the car. We are collaborating closely with cities to find a smarter way forward — a way that brings all stakeholders together in an easy-to-use, data-driven environment that can help make our cities safe, more livable and accessible, as well as drive new opportunities for multiple generations to come.

Congress plays an important role in helping states and municipalities fund various mobility initiatives. By experimenting and sharing best practices from these efforts, communities will continue to improve safety, traffic flow, and livability. This becomes increasingly important as more and more individuals move to metropolitan areas. Thank you for your efforts in helping to improve greater mobility access for all.

Sincerely,

Curt Magleby
Vice President, Government Affairs
Ford Motor Company

STEVEN J. GOLDBERG
Vice President & Deputy General Counsel
Regulatory Law and Government Affairs

October 25, 2019

Honorable Haley Stevens, Chair
Subcommittee on Research and Technology
Committee on Science, Space and Technology
U.S. House of Representatives
Washington, D.C. 20515

Dear Chairwoman Stevens:

Please accept this letter for the record in conjunction with your Field Hearing entitled, "*Smart Transportation and Mobility in Suburban Communities*". BASF Corporation is a proud corporate constituent in Livonia, Michigan, which you represent. BASF appreciates your efforts to address the research and innovation needs for this important sector of our economy.

BASF Corporation operates over 100 sites in 30 states and employs 20,000 people in North America and has the largest R&D spend in the chemical industry. At BASF, we create chemistry for a sustainable future. Chemistry is an enabler for many solutions across all sectors of our economy. We are pleased to be a solutions provider for the transportation and automotive sector.

With appropriate reference, BASF is pleased to share our thoughts as offered in an article we sponsored earlier this year on this important topic. We've enclosed a copy of that article for this statement. Thank you for the opportunity to share our views.

Very truly yours,

Steven J. Goldberg
Vice President & Deputy General Counsel
Regulatory and Government Affairs

Enclosure

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October 25, 2019

The Honorable U.S. Representative Haley Stevens
227 Cannon House Office Building
Washington, DC 20515

Re: U.S. House of Representatives Committee on Science, Space, & Technology
Field Hearing, Friday, October 25, 2019 at Livonia, Michigan

Dear Representative Stevens,

As you know, Toyoda Gosei (TG) is a leading global manufacturer in several categories of automotive products, including rubber and plastic automotive components, automotive safety systems, and LEDs. We are proud to call Michigan's 11th Congressional District home to both our Headquarters and Research & Development Center for the Americas Region.

Our aim at TG is original manufacturing that benefits society, for which we conduct ongoing research and development for advanced technology. Using our core technologies in safety systems, rubber, plastics, and LEDs, we have expanded development to address the future needs of the automotive industry.

As connected, autonomous, shared, and electrified (CASE) technologies become reality; we are working to develop technologies that contribute to the future of mobility. From advanced occupant and pedestrian safety systems to front grill modules that can sense the surrounding environment with cameras, millimeter wave radars, and signage functions that communicate the vehicle's operating status to people nearby with LED lights, TG is focused on designing and delivering products to meet the needs of smart transportation and mobility.

TG strongly supports your bringing this Field Hearing, addressing Smart Transportation and Mobility in Suburban Communities, to Michigan's 11th Congressional District. Thank you for bringing this important discussion directly to the center of the automotive industry.

Sincerely,

Greg Wells
Principal, Corporate Planning & Government Affairs

Rolls-Royce North America
1875 Explorer Street,
Suite 200
Reston, Virginia
20190 USA
Tel: 703-851-1700

22 October 2019

Congresswoman Haley Stevens
37695 Pembroke Ave.
Livonia MI 48152

Re: House of Representatives Science, Space, and Technology Committee
Livonia, MI Field Hearing, 25 October 2019

Dear Congresswoman Stevens,

Thank you for your role in scheduling and chairing the Committee field hearing on the topic of Smart Transportation and Mobility in Suburban Communities on 25 October. Innovations and advances in technologies including aircraft electrification, automation, and light commuter rail hold great promise for improving the transportation options for small and suburban communities. Rolls-Royce continues to invest in the development of power products that will drive new transportation solutions that are safe, clean, efficient, and reliable.

Rolls-Royce is developing new concepts and designs in electrical vertical take-off and landing (EVTOL) vehicles. Building on the experience gained by providing hybrid-electric propulsion systems for trains, marine vessels and other applications, the Rolls-Royce EVTOL design could be adapted for personal transport, public transport, logistics, and government purpose applications. As we move towards a low carbon economy, Rolls-Royce engines will become part of broader hybrid-electrical systems with lower emissions and environmental impacts.

Rolls-Royce has a long heritage of innovation in the world's railways. Our hybrid-electric PowerPacks for commuter rail transport are environmentally-friendly, quieter, and offer new opportunities for more efficient rail travel. The hybrid PowerPack combines the advantages of diesel and battery-powered rail traction, and represents a more economical way of moving to lower carbon rail transport than full electrification as it doesn't require the installation of overhead power lines.

Rolls-Royce is at the forefront of developing power products and drive systems for

Rolls-Royce North America
1875 Explorer Street,
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20190 USA

aerospace, marine, marine, and land-based transportation systems. We see continued opportunity in the rising demand for new and flexible power solutions that build upon our commitment to improved environmental performance while meeting the ever more sophisticated needs of today's, and tomorrow's, travelers.

Thank you for your attention to this important topic. Rolls-Royce looks forward to studying the results of the hearing. If you should have any questions or would like additional information, I would be pleased to respond soonest.

Best Regards,

Geo. K

George Kampstra, Vice President
Rolls-Royce North America

HARMAN
A SAMSUNG COMPANY

October 21, 2019

Congresswoman Haley Stevens
United States Representative for Michigan's 11th Congressional District
227 Cannon HOB
Washington, DC 20515

Dear Representative Stevens,

The transportation industry is currently undergoing an unprecedented transformation with disruptive technologies and shifting consumer expectations driving the change. Cutting edge solutions like cloud enabled sensors, smart audio and Vehicle-to-Everything (V2X) communications will bring improved safety, efficiency, environmental benefits and accessibility to diverse communities of all kinds.

When it comes to advancing the future of mobility and transportation, robust engagement between public and private entities is essential for enabling meaningful innovation and fostering consumer trust.

As leaders in the connected and autonomous vehicle space, HARMAN supports the October 25th, 2019 field hearing "Smart Transportation and Mobility in Suburban Communities," hosted by Congresswoman Haley Stevens. We are proud to engage Congress, regulators and other public sector organizations to educate them on the technical aspects and potential benefits of relevant mobility technologies.

Sincerely,

Darrin Shewchuk

Vice President of Public Affairs and Communications
HARMAN
400 Atlantic Street, 15th Floor
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GENERAL MOTORS

Elizabeth Reicherts
Vice President, External Affairs
Global Public Policy
25 Massachusetts Avenue, N.W.
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October 25, 2019

The Honorable Haley Stevens
Chairwoman, Subcommittee on Research and Technology
Committee on Science, Space and Technology
U.S. House of Representatives
227 Cannon House Office Building
Washington, DC 20515

Dear Chairwoman Stevens,

General Motors (GM) is pleased to support your field hearing on "Smart Transportation and Mobility in Suburban Communities." As you know, the automobile industry is going through significant changes to the way we do business. Traditional models of new vehicle sales are being challenged by self-driving vehicles, electric vehicles, ridesharing, carsharing and many other new exciting opportunities. We thank you for your attention to this timely topic and welcome the opportunity to submit this letter for the record outlining GM's vision for the future.

At GM, we are guided by our vision of a future with zero crashes, zero emissions, and zero congestion. As you know, smart transportation and smart transportation technology play an important role in moving towards this future state. The continued research and deployment of intelligent transportation technologies, including in suburban communities, will help to save lives, improve mobility, increase transportation efficiency, and provide more accessibility for underserved communities. GM has been an industry leader in these technologies, particularly in the areas of advanced safety features, self-driving vehicles, electric vehicles and connected cars.

Advanced Safety Features

The National Highway Traffic Safety Administration (NHTSA) has found that human choice or error is a factor in approximately 94% of all motor vehicle crashes on U.S. roads – crashes that took the lives of over 37,000 men, women, and children in 2017. General Motors has systems in place designed to help protect passengers before, during and after a crash and has developed various driver assistance features that help warn drivers to mitigate the risk of an accident occurring. As the Committee explores Smart Transportation and Mobility, we welcome the opportunity to highlight some of the technology in our vehicles today that go beyond helping to protect occupants before, during and after a crash – these advanced driver assistance systems can

help drivers to mitigate the risk of a crash happening by reducing driver distraction and promoting driver engagement. Specifically, they include:

- **Front Pedestrian Braking** - If the system detects that a pedestrian is directly ahead, a collision is imminent, and the driver has not already applied the brakes, the system can alert the driver and may even automatically apply the brakes to help the driver avoid or reduce the harm caused by the collision.
- **Forward Automatic Braking** - If the system detects that a front-end collision situation is imminent while following a detected vehicle and the driver has not already applied the brakes, the system can automatically apply the brakes to help reduce the collision's severity. The system may even help avoid a collision at very low speeds.
- **Adaptive Cruise Control Camera** - This feature enhances regular cruise control. The cruise control speed is automatically adapted to maintain a driver-selected gap between the vehicle and vehicles detected ahead while the driver steers, reducing the need for the driver to frequently brake and accelerate.
- **Rear Vision Camera** - When in reverse, this feature provides the driver with a view of the scene directly behind the vehicle on a center stack or inside rearview mirror display to help them park and mitigate the risk of crashing into nearby objects during low-speed maneuvering.
- **Lane Change Alert with Side Blind Zone Alert** - This available feature can provide side mirror alerts to help the driver mitigate the risk of crashing into a moving vehicle detected in their side blind zone or a vehicle that is rapidly approaching their side blind zone during a lane change maneuver.
- **Lane Keep Assist with Lane Departure Warning** - Provides gentle steering wheel turns (and Lane Departure Warning alerts if necessary) to help drivers mitigate the risk of a crash due to unintentionally drifting out of their lane when they are not actively steering, and their turn signal is not activated.
- **Side Blind Zone Alert** - Provides side mirror alerts to help the driver mitigate the risk of crashing into a moving vehicle detected in their side blind zone during a lane change maneuver.
- **Forward Collision Alert** - If the system detects that a front-end collision situation is imminent while following a detected vehicle, the system can alert the driver to a potential crash. It also can provide an alert if the driver following a detected vehicle too closely.
- **Rear Cross Traffic Alert** - When in Reverse, this feature can provide alerts to help the driver mitigate the risk of crashing into approaching detected left- or right-traveling cross traffic or pedestrians (e.g., out of a crowded parking space or driveway with side obstructions).
- **Call Me Out** - This is an innovative app that lets friends remind each other that when driving they should keep their eyes on the road and hands off their phones.
- **Teen Driver** - Teen Driver offers several safety functionalities, from the available industry-first Buckle to Drive[1] feature, to muting audio until front-seat occupants are buckled to automatically turning on available active safety technologies. Plus, the in-

[1]https://media.chevrolet.com/media/us/en/chevrolet/home.detail.html/content/Pages/news/us/en/2019/may/0521-btd.html

vehicle report card shows information about your teen's driving, to help you identify potential problem areas and coach your new driver on improvements.

- **Rear Seat Reminder** - Rear Seat Reminder works by monitoring the vehicle's rear doors. If either rear door is opened and closed within ten minutes before the vehicle is started, or if they are opened and closed while the vehicle is running, the feature is intended to activate an audible chime and visual alert reminding the driver to check the rear seat.
- **Front and Rear Park Assist** - When traveling below 5 mph (8 km/h), available Front and Rear Park Assist can provide distance-to-object alerts to help the driver park and mitigate the risk of crashing into nearby detected objects directly ahead or behind the vehicle during low-speed maneuvering.
- **Following Distance Indicator** - Available Following Distance Indicator can provide drivers with the following (or headway) time to a moving vehicle detected in front of them to help alert them if they are following too closely.
- **Safety Alert Seat** - The available Safety Alert Seat provides the driver the option of getting haptic seat-bottom vibration pulses instead of audible crash avoidance alerts. The Safety Alert Seat pulses on the left, right or both sides of the seat to alert you to the direction of the possible danger.

Self-Driving Vehicles

Fully self-driving vehicles have the potential to eliminate human error and behavior. Self-driving may help prevent crashes from happening and reduce injuries and fatalities on our roadways. Safety is our number one priority for this technology, and we believe that a safe self-driving vehicle must be built from the ground up with seamless integration with the self-driving system. When it comes to self-driving vehicles, General Motors is in a unique leadership position with everything from design, engineering, validation and testing all under one roof. Building our test AVs in a factory such as Orion Assembly and using mass production methods allows us to meet the same strict standards for safety and quality that we build into all our vehicles. General Motors is also partnering with Cruise Holdings LLC ("Cruise") to bring everything from design, engineering, validation and testing all under one roof.

General Motors and Cruise are currently testing 180 self-driving vehicles in San Francisco, Phoenix and metro Detroit. These test self-driving cars have human driver controls and human safety drivers. Our AVs are specifically designed from the ground up to incorporate safety and redundancy systems to help ensure the safe operation of the vehicle when in self-driving mode. While our early versions were based on the Bolt Electric Vehicle (EV) platform, 40% of the content in the current test vehicles are new or significantly updated compared to a retail Bolt EV.

A legal and regulatory framework that ensures safety and provides a path for the deployment of self-driving vehicles will play an important part in the rollout of this exciting technology and unlock the many benefits to society. We encourage Congress to consider Federal self-driving vehicle legislation to create a safe, expeditious and scalable path to deploy this potentially life-saving technology. Last Congress, both the House of Representatives and the Senate recognized the importance of providing a federal framework for self-driving cars and moved critical legislation from key committees in both Chambers. The House of Representatives passed a self-driving vehicle bill by voice vote.

We recognize the potential of this technology to positively impact millions of Americans and strongly encourage Congress to pass legislation this year that allows self-driving technology innovation to move forward in the United States. The U.S. has been a leader in the automotive industry for over 100 years. We need a smart legal and regulatory framework to safely facilitate the deployment of this innovative technology thus maintaining our American tradition of automotive leadership.

Electric Vehicles

GM believes in an all-electric future and is committed to driving increased usage and acceptance of electric vehicles that meet our customers' needs. We remain the only manufacturer in the market to offer a truly affordable, long-range electric vehicle—the Chevrolet Bolt—that will now offer 259 miles of EPA-estimated range in Model Year 2020, a 9 percent improvement over the existing model. The Bolt also provides the platform for our cutting-edge autonomous vehicles, all of which will be electrified to ensure that our shared and autonomous future is also a part of the climate solution.

The Chevrolet Bolt EV is a prime example of our unwavering commitment: we were the first automaker to invest in and launch a truly affordable, mass-market, long-range EV. It has been widely praised and represents just the first step on our path to an all-electric future, with more EV models to debut in the coming years, including entries in the truck segment. GM also stands out in front as the only automaker calling for a comprehensive National Zero Emissions Vehicle (NZEV) Program. We estimate that the NZEV program could place more than 7 million long-range EVs on the road by 2030.

US policy on EVs has lagged behind, while China and Europe have moved ahead. Despite our significant investments in EVs, the current US market adoption rate for EVs is less than two percent. Since battery prices remain a significant cost barrier to market entry, we urge Congress to update the current EV tax credit by lifting the per manufacturer cap on available customer tax credits. This adjustment is key to making EVs cost-competitive with internal combustion engines (ICEs) until more EVs are deployed at scale and costs come down. GM believes the "Driving America Forward Act," of which you are a cosponsor, is a good solution to this problem, and we thank you for your support.

In addition, we urge Congress to allocate federal funding to build out EV charging infrastructure. Even though most charging currently takes place at home or at the workplace, range anxiety remains a barrier to consumer adoption of EVs. Building a nationwide fast charging infrastructure would provide the necessary consumer confidence to ensure they have the freedom to drive coast to coast with their EV. These policies are critical to maintaining our competitiveness and ensuring that the US leads the world in electric vehicle battery technology.

Connected Vehicles

GM is committed to Vehicle-to-Vehicle (V2V) and Vehicle-to-Infrastructure (V2I), collectively known as Vehicle-to-Everything (V2X), as a key technology for improving transportation safety and mobility. GM deployed V2X capabilities in the U.S. market in 2017 on the Cadillac CTS, and we announced plans to eventually expand the deployment to other Cadillac models. This planned expansion of V2X communications to all Cadillac vehicles underscores the importance

of ensuring that automakers retain access to spectrum to support their growing connected vehicle safety needs.

Congress can support the continued deployment of connected vehicle technologies by ensuring that the 5.9 GHz band remains dedicated to auto safety and is not opened for unlicensed use unless there are enough test results that demonstrate that unlicensed devices would not interfere with critical life-saving systems.

Michigan is a leader in Smart Transportation and Mobility

Perhaps no location showcases our commitment to zero, zero, zero more than GM's 90-year-old Milford Proving Grounds, located in your district. With our GM headquarters in Michigan, we have strong roots throughout the state and are partnering with key stakeholders on smart transportation and mobility projects. Specifically:

- **Vehicle Connectivity** - GM has worked with Macomb County and the Michigan Department of Transportation to test a Connected Vehicle safety feature that warn drivers when traffic signals are about to turn red. The system, which works up to 1,000 feet from a traffic light, does not brake the car. The alert can help prevent drivers from having to stop abruptly or from speeding through an intersection to beat the light change.
- **Car Sharing** - GM is also exploring how new models of shared use can contribute to a zero, zero, zero future. The future of car ownership is changing, but the need for cars is not diminishing. Cars continue to serve a greater number of purposes, making owning and using them more efficient. Through its Maven brand, GM recognizes the need to actively participate with cities and other stakeholders to design next-generation transportation systems. This year, through a unique public-private partnership with the City of Detroit, we offered unique insights and shared business frameworks to design, implement and invest in these types of systems in places where Maven members live and play. We also believe that when the sharing economy is coupled with smart technology and accessibility, social and economic opportunities arise for those communities with whom we have partnered. Cities are focused on accessibility for all residents. Understanding the unique needs of individual communities will help the City, Maven, and other stakeholders create mobility options that enable such accessibility to community members.

Thank you for holding this very important and timely hearing. General Motors looks forward to continuing to collaborate with you and your colleagues in Congress on policy solutions to move towards a zero, zero, zero future.

Sincerely,

Elizabeth A. Reicherts
Vice President, External Affairs

ZF Group
12001 Tech Center Drive | Livonia | MI 48150

Department External Affairs
From Brian Laughlin
Email brian.laughlin@zf.com
Date October 25, 2019

The Honorable Haley Stevens
The Honorable Jim Baird
House Committee on Science, Space, & Technology
Subcommittee on Research & Technology
2321 Rayburn House Office Building
Washington, DC 20515

Dear Chair Stevens, Ranking Member Baird, and Members of the Subcommittee:

Thank you for holding today's field hearing on "Smart Transportation and Mobility in Suburban Communities." This is an increasingly important topic, and is deserving of the attention afforded by a field hearing.

Headquartered in Livonia, ZF North America is a leader in vehicle active and passive safety and powertrain systems, serving all major vehicle manufacturers, and manufacturing those products here in the United States. We are honored that today's hearing will take place at nearby Livonia City Hall, and we look forward to assisting the Committee in its ongoing analysis of smart mobility.

ZF is actively engaged in the development and deployment of technology that achieves our Vision Zero goal of a future with zero accidents and zero emissions. We are working with government, industry, academia and other public partners to help realize this vision while simultaneously responding to the need for safe and efficient mobility in small towns and suburban communities.

Through our joint venture, e.GO Moove GmbH, ZF is actively testing new electric and autonomous people movers that will provide more reliable and efficient shared transit. ZF has also been a partner to communities, universities, and research institutions in the U.S. that are considering and developing next-generation mobility solutions that address challenges ranging from maximizing vehicle utility and efficiency to ensuring reliable and safe disability access.

Moving forward, ZF appreciates the critical role that the federal government will continue to play in enabling the next generation of mobility services and ensuring that the transition is inclusive of all Americans. We appreciate the Committee's consideration of this important topic, and we look forward to supporting your ongoing work.

Best regards,

Brian Laughlin
Head of External Affairs

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ITS AMERICA

October 25, 2019

The Honorable Haley Stevens
Chair
Subcommittee on Research and Technology
Committee on Science, Space, and Technology
United States House of Representatives
Washington, DC 20515

The Honorable Jim Baird
Ranking Member
Subcommittee on Research and Technology
Committee on Science, Space, and Technology
United States House of Representatives
Washington, DC 20515

Dear Chair Stevens and Ranking Member Baird:

In anticipation of the House Subcommittee on Research and Technology upcoming field hearing entitled "Smart Mobility: It's a Community Issue," the Intelligent Transportation Society of America (ITS America) writes to underscore how advances in robotics, artificial intelligence, and wireless communications will define the way people, goods, services, and information move in the 21st century.

Mobility is less about moving vehicles and more about moving people, data and freight. Long-existing silos among cities, states, counties, road and transit agencies are disappearing, and transportation network companies and other mobility service providers barely existed a decade ago. More choices exist now, but for people to fully realize the benefits of this new world of mobility, it must be easier to choose which option best meets their needs. This also means services should be accessible to everyone and in all communities and neighborhoods.

Technology innovation is enabling Mobility on Demand (MOD), which will expand mobility choices and fill access gaps including first/last mile services in cities, suburban areas, exurbs, and rural communities. As defined by the U. S. Department of Transportation, MOD is an innovative, user-focused approach which leverages emerging mobility services, integrated transit networks and operations, real-time data, connected travelers, and cooperative Intelligent Transportation Systems (ITS) to allow for a more traveler-centric, transportation system-of-systems approach, providing improved mobility options to all travelers and users of the system in an efficient and safe manner. MOD is a vision for an integrated network of safe, carefree, and reliable transportation options that are available to all.

In cities, MOD offers convenient, affordable, and, in the case of bikeshare, rideshare or micromobility services, more sustainable alternatives to driving within congested environments. For suburban areas, MOD offers first mile/last mile accessibility to mass transit, as well as more dynamic on-demand services to get around town. While often seen as an urban/suburban transportation solution, MOD deployed in exurban and rural areas also provides first mile/last mile connections to transit, intercity bus and rail transport, and essential air service airports. Rideshare and ride sourcing is providing support for seniors in rural areas to access social and health services. New and improved MOD transit and paratransit services also can benefit rural communities. Tompkins County, NY, is an excellent example of a rural community pushing carshare (Ithaca Carshare), rideshare (ZimRide), and transportation network companies (TNC) (Lyft/Uber) services, and it received funding through the Shared Use Mobility Center MOD On-Ramp Program.

MOD is more than simply mobility services for traveler; it is an integrated system of mobility management. It is a series of different building blocks that fuel how MOD is advancing a more seamless, traveler-centric, intelligent mobility future by focusing on:

- How viewing transportation as an "on-demand" commodity where both the public and private sectors are providing supply and responding to demand may impact how we achieve equity, accessibility and congestion relief;
- How cities, states and private mobility providers are looking differently at the type of infrastructure services and management they offer as mobility services like ridesourcing with TNCs, micromobility like shared scooters or e-bikes, micro-transit, and dynamic cargo delivery transform how people and goods move;
- How more robust data services are changing how people define and conduct real-time mobility operations and plan for longer-term mobility needs, as well as how data is really fueling the "business" of mobility;
- How pricing systems can better enable curb side management or how creating seamless trip planning and payment apps are reshaping the relationship with mobility customers; and
- How customers are really driving more how mobility is being planned and delivered, especially as the private sector is in many ways rewriting their service expectations.

The following includes urban, suburban, exurban, and rural MOD use cases. In order for policymakers at local, state, and federal levels as well as public and private transportation and mobility operators to realize the benefits of this new world of mobility, it is critical to address the policy, business models and shared values that power MOD, whether funding and program benchmarks, integrated operations, data sharing, pricing models or public benefits of equity, accessibility and sustainability.

BATA Partners for Late-Night Mobility (MI): The Bay Area Transportation Authority (BATA) has collaborated with Lyft to offer free transportation between 11pm and 1am along the Bayline route in Traverse City, Michigan. Through this 12-month pilot, Bayline riders can use a monthly promotional code for up to $100 in late-night Lyft rides traveling to/from locations within a 0.2 mile-radius of the Bayline route. The promotional code can be found inside Bayline buses and is valid for a month, after which a new code will be available. Rides can be scheduled through the Lyft app and wheelchair accessible vehicles are available upon request. The program aims to fill gaps in existing public transit service by helping Bayline commuters get home safely after regular bus service has ended.

Partnership for Non-Emergency Medical Transportation Service in Dayton, OH: The Greater Dayton Regional Transit Authority (RTA) has partnered with Ford Motor Company to offer Ford GoRide Health (GoRide) on-demand paratransit service in Dayton, Ohio. GoRide, powered by Ford, will be offered as part of RTA Connect. Through this partnership riders can order wheelchair accessible rides on-demand, which helps connect individuals with disabilities to healthcare and other services. All GoRide drivers have been professionally trained to assist passengers and are Health Insurance Portability and Accountability Act (HIPAA) compliant. By partnering with Ford, RTA aims to enhance its non-emergency medical transportation, complement existing mobility options, and improve first/last mile access.

Onondaga County (NY) Partners with Lyft to Help Job-Seekers on Welfare: Onondaga County has partnered with Lyft to launch a new pilot program designed to help individuals on welfare go to work. Through this program, Onondaga County – together with the employment agency JOBSPlus! – will offer eligible residents free Lyft rides to local companies looking to hire, as well as to childcare if needed. While welfare recipients in Syracuse usually receive bus passes, ride-hailing may better accommodate those trying to commute during late hours or to areas away from transit. This pilot, paid for using the

publicly-funded budget of JOBSPlus!, aims to reduce transportation barriers facing job-seekers and make it easier for more people to get to work.

Partnership with Ford-owned Spin for Scooter Sharing Pilot in Ann Arbor, MI: The city of Ann Arbor, the University of Michigan (UM), and Ford-owned scooter company Spin have partnered to bring dockless, electric scooters to the Ann Arbor area. Through this partnership, 200 scooters are available for use on and around the UM campus. Scooters can be unlocked via the Spin app for $1 plus $0.15 per minute. The scooters can accelerate up to 15mph and may be operated on streets with speed limits less than 45mph, as well as on sidewalks – though some crowded areas on UM's campus have been geofenced as no-ride zones. The scooters provide riders with instructions on parking and safety. Free helmets are also available upon request. This one-year pilot aims to offer a flexible, integrated mobility option.

Partnership between UTA & the Transit app in the Wasatch Front Region, UT: The Utah Transit Authority (UTA) has partnered with the Transit app to offer integrated, personalized trip planning. Through the Transit app, riders can access real-time information regarding nearby bus and rail options. The app provides transit departure times, allows for real-time tracking, and enables users to receive route-specific push notifications. Transit's Go feature also offers step-by-step navigation, and riders can use the app's Transit+ feature to get information on other modes – including Lyft, Uber, GREENbike, and Spin – for their first/last mile travel needs. Riders can book and pay for Lyft and Uber rides within the app. By partnering with the Transit app, UTA aims to facilitate multimodal trip planning and transit use.

COTA Launches Microtransit Program (OH): The Central Ohio Transit Authority (COTA) partnered with Grove City and Via to launch on-demand microtransit service, COTA Plus. Through this one-year pilot, which began July 15, residents and visitors in Grove City can book local rides on six-passenger vehicles through the COTA Plus app or by phone. The vehicles are operated by COTA drivers and can be used to connect passengers with any destination of their choice within the program service area (for a base fare of $3) or designated COTA transit lines (for free). Day passes and weekly passes are available, and COTA Plus vehicles should arrive within 15 minutes of booking. This pilot aims to improve first/last mile mobility and offer a convenient, affordable transportation option.

Pilot with Lyft for Rides for Individuals with Disabilities in Dakota County, MN: Dakota County has partnered with Lyft to offer flexible, on-demand rides to individuals with disabilities who receive home and community-based services in Dakota County. Through this pilot program, eligible individuals may use Lyft credits, paid through Medicaid waivers, to order rides to/from work and community activities. These rides aim to supplement existing transportation options and make it easier for individuals with disabilities to access jobs and get around independently. The partnership is supported in part by a grant from the Minnesota Department of Human Services.

NYCDOE Teams Up for "Via for School Bus Routing and Tracking in New York City: The New York City Department of Education (NYCDOE) has partnered with ridesharing company Via to launch "Via for Schools." The "Via for Schools" platform enables dynamic school bus routing and real-time tracking via mobile app, which also automatically communicates schedule updates. The platform is "designed to serve the city's diverse student populations, including general education, special education, students in temporary housing, and others through one integrated school transportation system." Through this partnership, NYCDOE aims to make communication regarding bus service more efficient and help make transportation to and from schools safer and more reliable.

Partnership for MOD Microtransit Service for Seniors in Newton, MA: The city of Newton has partnered with Via to launch Newton in Motion (NewMo), an on-demand microtransit service for seniors. Through this program, Newton residents over the age of 60 can order NewMo rides using the Via app or by phone. After booking, riders will be directed to nearby virtual bus stops where they will be picked up and may share a ride with other passengers traveling similar routes. NewMo service is available from 8am to 5pm on weekdays and from 9am to noon on weekends. This on-demand service replaces the previous taxi voucher system that required users to book rides at least 72 hours in advance. NewMo aims to offer convenient, reliable mobility to help seniors travel around the city.

Partnership with TransLoc for Microtransit Service in the Village of Milan, IL: The Rock Island County Metropolitan Mass Transit District (MetroLINK) has partnered with Ford Smart Mobility company TransLoc to launch an on-demand microtransit pilot program. Through this pilot, riders in Milan can order a 12-passenger, wheelchair accessible van for local curb-to-curb microtransit service. To use the service, riders can request rides through TransLoc's Microtransit app.. Same-day rides can also be requested via phone call. Trips cost $1 for standard passengers (with discounted rates available for students and designated individuals). The service, which aims to enhance mobility, is owned by MetroLINK and will be evaluated based on on-going performance information provided by TransLoc.

Zipcars Now Available at Rail Stations in Baltimore, MD: The Maryland Department of Transportation's Maryland Transit Administration (MDOT MTA) and Zipcar have partnered to offer car-sharing service at select rail stations and enhance transportation options in Baltimore. Through this partnership, 15 Zipcars are available for on-demand use at eight rail stations along the Light Rail Link, Metro Subway Link, and Maryland Area Regional Commuter (MARC) train lines. Transit riders can reserve vehicles for one hour or up to seven days after joining Zipcar. The reservation cost includes gas, insurance, and maintenance. By partnering with Zipcar and adding a sustainable mobility option at local transit stations, MDOT MTA hopes to increase connectivity and reduce the need for commuters to drive.

Chesterfield County (VA) Partners with Uber and Goodwill to Connect People with Critical Services: Chesterfield County has partnered with Uber and Goodwill of Central and Coastal Virginia to launch a pilot program providing free, treatment-related transportation to individuals trying to overcome opioid addiction. Through this program, those undergoing treatment through the county's Mental Health Support Services Department who do not own a personal vehicle can take an Uber, free of charge, to any pre-approved location. Participants can reserve rides from 6 am- 6 pm, Monday through Saturday, by calling Goodwill. Goodwill contacts Uber and oversees the trips, and rides can also be reserved in advance. The pilot, funded through a state grant, aims to make it easier and more affordable for recovering participants to seek treatment.

Pinellas Suncoast Transit Authority Making Trip Planning and Travel More Seamless (FL): The Pinellas Suncoast Transit Authority (PSTA) selected the Transit app as the official trip planning application of Pinellas County. The Transit app offers an easy-to-use, multi-modal platform, through which users can access real-time information regarding PSTA's transportation options and arrival/departure times. The application also integrates information on MOD services, so that transit riders can, for example, check local bikeshare availability or request an Uber ride as needed from within a single app. As part of this partnership, PSTA will officially advertise the Transit app, and the Transit app will share anonymous data regarding users' trip behavior, which can better inform PSTA planning and operations.

The framework for aggregating and managing supply and demand depends on connected data rather than particular technology. MOD is powered by technology and mobility services that currently and will include:

- Data systems and data analytics platforms, specifically open data platforms, open source technologies, and data sharing agreements that allow public and controlled access to mobility data to plan real-time operations and longer-term planning;
- Asset management systems (parking, curb, freight delivery), specifically to provide opportunity for mapping assets to develop more comprehensive use management strategies and value pricing systems (e.g. assessing a fee for curb-side passenger drop off, or use of designated delivery or drop-off zone or conversely a fee for not using provided zones);
- Security/safety systems, which can include physical technologies – like locking systems for bikeshares where bikes must be secured at the end of a trip – or cybersecurity systems. With the potential introduction of automated/autonomous vehicles into MOD services, like rideshare, it will be increasingly important to have systems that monitor performance and track/mitigate any security breaches. It also may be increasingly important to have systems that confirm the intended rider and potentially (in the case of AVs, for example) monitor riders' safety throughout their trip.
- Geospatial Technology: defined as the collective data and associated technology that has a geographic or locational component; technology used to acquire, manipulate, and store geographic information. Geographic Information Systems (GIS) is one form of geospatial technology. GPS, remote sensing, and geofencing are other examples of geospatial technology. Geofencing, for example, is being used in scootershare and bikeshare programs to monitor use and designate certain areas as no-go or no-park zones.
- Connected vehicle platforms and data, specifically to provide opportunity for real-time operations such as deployment of emergency service providers, rerouting of traffic during major events, and fleet management (public or private);
- Integrated trip planning technology platforms that power travel across a variety of modes, including public transportation, TNCs, car and bike sharing services, micro-transit providers, and even private vehicle mobility planning;
- Integrated booking and payment systems that power seamless travel across a variety of modes to include both public and private mobility services;
- Integrated payment systems for transportation adjacencies or value-pricing asset usage (e.g., tolling, congestion pricing, dynamic parking, curb-side pricing, motor vehicle administrative transactions, electric charging stations);
- Integrated payment systems that include other specialized and demand-response transportation (e.g., human service transportation, faith-based transportation, non-emergency medical transportation, paratransit, volunteer-based transportation, closed or open loop shuttle services, employee and campus transportation); and
- Integrated payment systems that could include multiple non-transit/non-mobility services (e.g., retail, incentivization, loyalty programs); social programs (e.g., travelers with disabilities, student discounts, transit benefits, social security, senior citizens, veteran benefits, human service programs); and access and authorization (e.g., student cards, government IDs, campus/ academic cards, library access, community and facility access, municipal programs, age-based programs).

In the future, Augmented Reality (AR) enhanced by 5G connectivity could make MOD and the delivery of real-time data even more useful. For instance, AR can be used to create interactive maps to help people

navigate transit systems. By using the camera in a traveler's mobile device and superimposing digital information on what the camera is capturing, AR can make it easier for the user to make more informed decisions based on up-to-date information. Holding a mobile device on top of a transit map, for example, would allow users to see real-time movement of trains and buses near their location.

ITS America's FAST Act Reauthorization Platform: *Moving People, Data, and Freight: Safer. Greener. Smarter.* supports establishing a MOD program that encourages flexibility within federal transportation programs to meet changing mobility needs, including partnerships with companies offering shared-use trips (car, bicycle, new mobility modes), data management, and other technology companies for first mile/last mile services and improved freight delivery, the integration of mobility services and technologies, and new fare and integrated payment technologies. ITS America supports a MOD program that establishes a data sharing framework providing standardization for the transfer of data among transportation operators and providers to foster the efficient use of capacity, enhances management of new modes of mobility, and promotes the creation of innovative planning tools.

The transportation sector in communities across the nation is undergoing historic transformations with the promise of greatly boosting the safety, access, equity, and sustainability of our transportation system.

New forms of mobility are being deployed even as others are being developed. When cars were invented a century ago, Departments of Roads were created to build infrastructure for this new form of transportation. Those agencies are now Departments of Transportation, having grown to include many modes of transportation. Now those same agencies are evolving again to provide seamless multimodal mobility and to build smart infrastructure that will support the technology-driven 21st-century economy, which is all about moving, people, data, and freight.

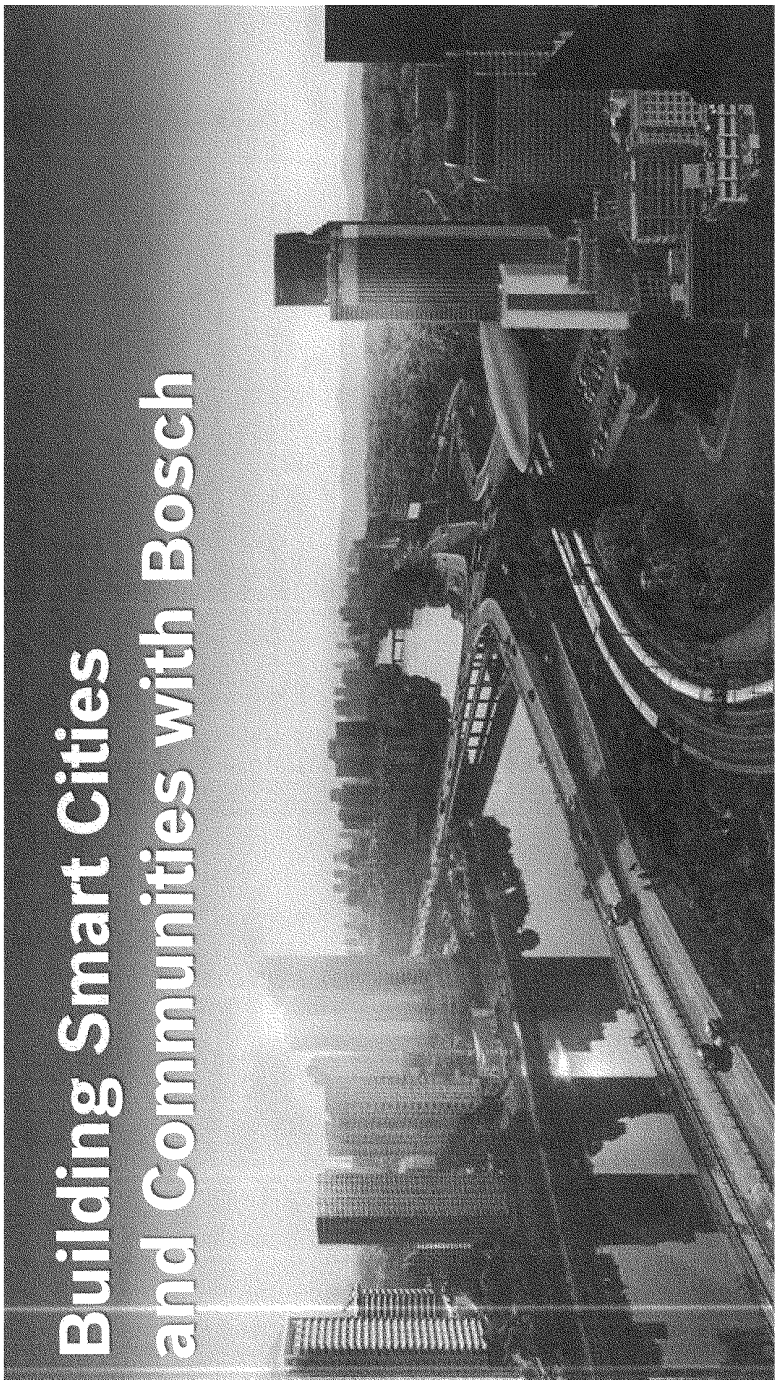
Changes are happening today that will fundamentally affect how people interact with transportation in the months and years ahead. ITS America is helping cities, suburban communities, states, the private sector, and researchers as we work toward our vision of a better future transformed by Mobility on Demand - one that is safer, greener, and smarter.

Sincerely,

Shailen P. Bhatt
President and CEO
Intelligent Transportation Society of America

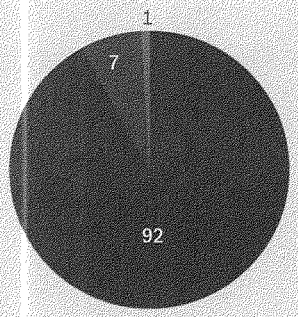
Cc: House Subcommittee on Research and Technology
Ron Thaniel, ITS America Vice President of Legislative Affairs, rthaniel@itsa.org

PRESENTATION SUBMITTED BY MR. SCOTT AVERITT



Building Smarter Cities and Communities
Bosch Global Footprint - Four business sectors

Shareholders



1 Robert Bosch GmbH
7 Bosch family
92 Robert Bosch Stiftung

4
Business sectors and divisions

- Mobility Solutions
- Industrial Technology
- Consumer Goods
- Energy and Building Technology

Mobility Solutions

World's largest supplier of cutting-edge automotive technology

Industrial Technology

Leading in drive and control technology, packaging, and process technology

Consumer Goods

World's largest power tool manufacturer
Leading the field in household appliances

Energy and Building Technology

Leading manufacturer of thermo, and building security technology; World's largest supplier of heat pumps

approx. **410,000** associates

89.2 billion dollars in sales in 2018

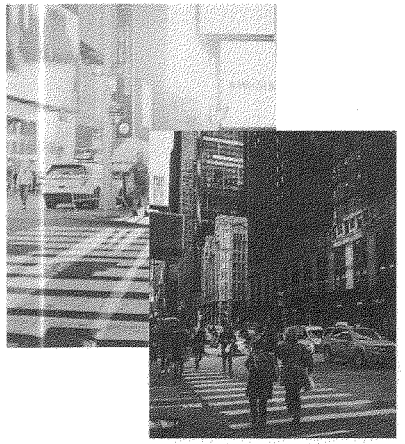
RBNA/GOV1.2 | 2019-10-18

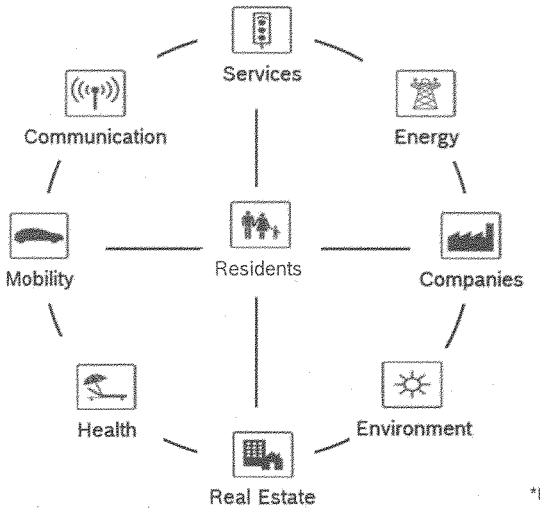
BOSCH

Building Smarter Cities and Communities
Smart City and Smart Community

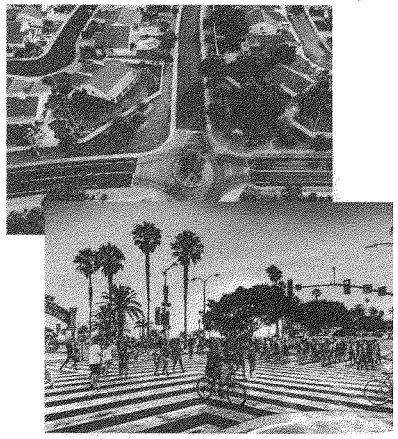
Our **vision** for a smart city is to create an **interconnected ecosystem** that works to optimize **performance,** increase **efficiency,** and to enhance **quality of life** for all.

Smart City





Smart Community



*Photos free to use from Unsplash.com

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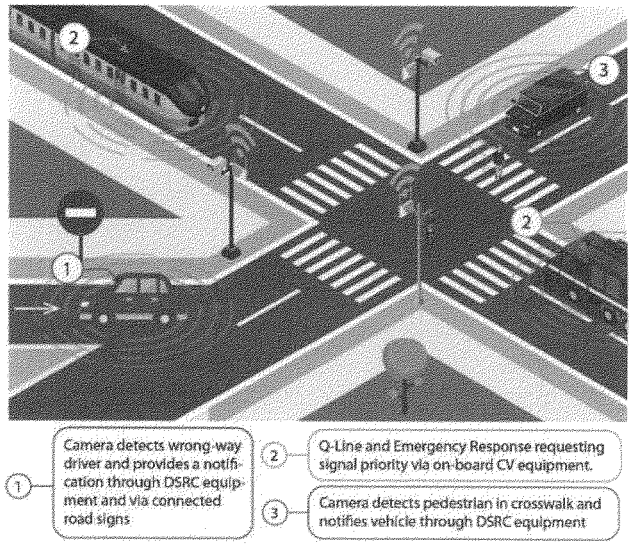
Intelligent Traffic Systems
ITS example – US DOT ATCMTD submission

MDOT Michigan Department of Transportation

- Pedestrian detection, prioritization, and alerts
  - Improved pedestrian and vehicle safety
- Traffic intersection preemption and signal priority for authorized vehicles
  - Reduced response times for emergency vehicles
  - Improved on-time arrivals for public transportation
- Vehicle to Vehicle (V2V) and Vehicle to Infrastructure (V2I) communications
- Transportation system optimization through data analytics and edge computing
- Wrong way driver detection and alerts
- Incident and near miss detection



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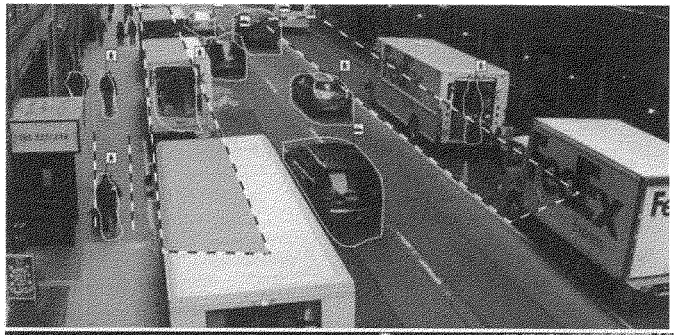
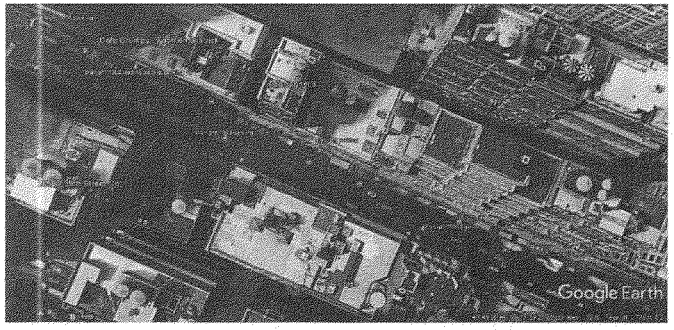
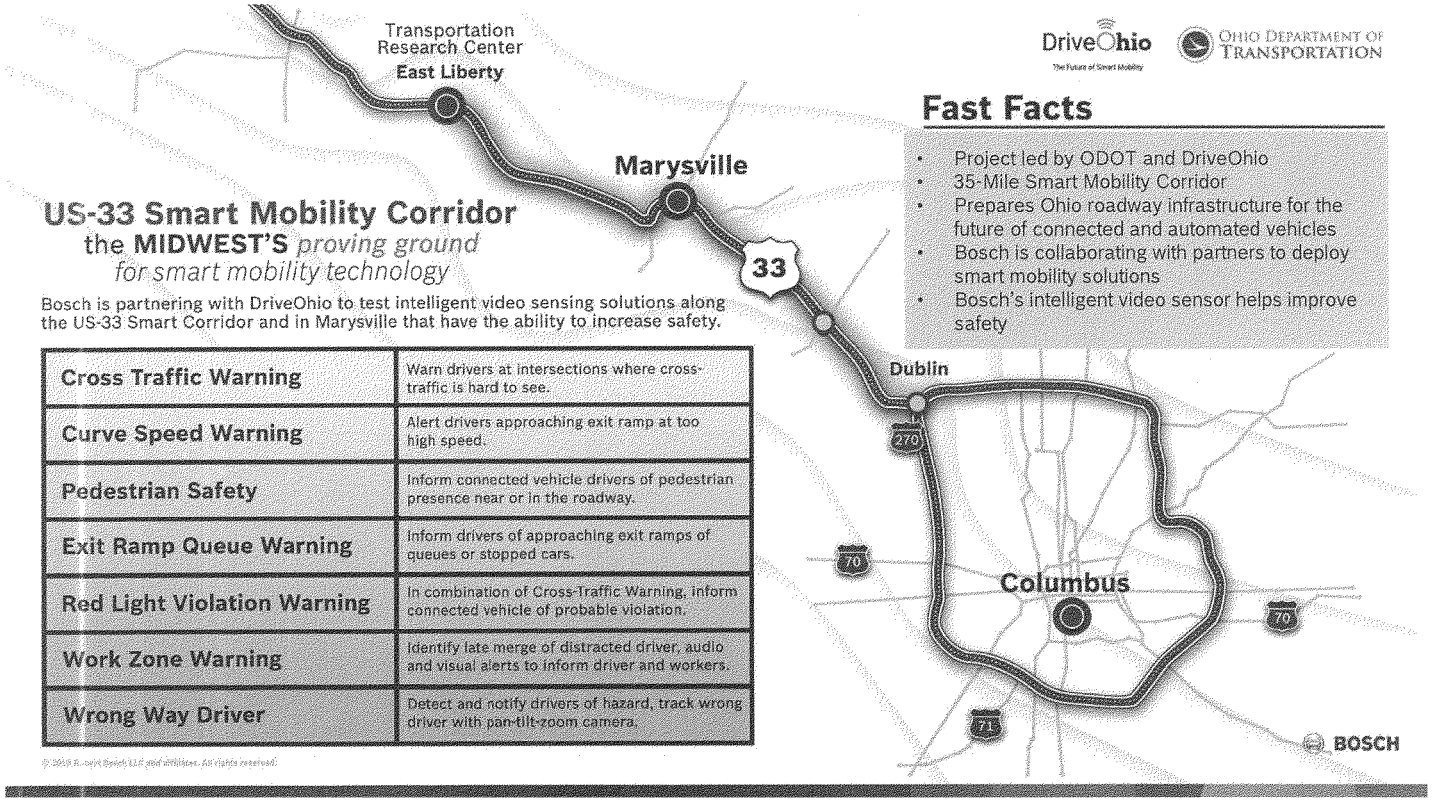
Intelligent Traffic Systems Curbside Management Pilot

- Car & Truck counting with Dashboard
- Truck parking analytics, frequency & duration
- Delivery zone violations and availability
- Double parking detection
- Bus stop & ride-share violation detection





BOSCH



Autonomous Mobility Services
US DOT grant award – Truck Platooning

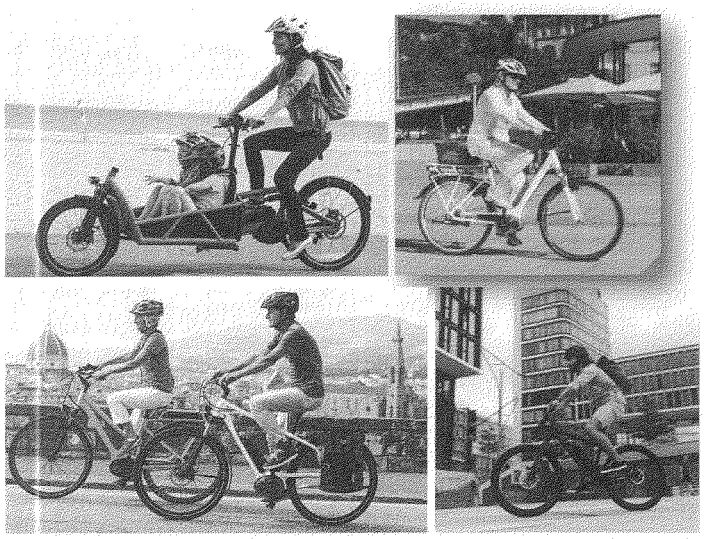
DriveOhio
The Future of Smart Mobility

Ohio Department of Transportation

- Ohio Department of Transportation (ODOT) and DriveOhio to Test and Deploy Automatic Driving System Technology in Ohio
- Bosch is a sub-awardee on this project as a technology provider for level 1 & 2 autonomous functionality to enable truck platooning.
- Benefits of truck Platooning
  - Improved road safety
  - Decreased fuel consumption
  - Improved freight logistics efficiency resulting in positive economic impact

BOSCH

Bosch eBike Systems
eBike Pedal-assist System



- **Pedal-assist**: Electric motor engages only when pedaling, allowing precise assisted speeds of up to 20 or 28 mph, no throttle needed and either hand is free
- **Power and range:** the 350-watt motor is powered by a 500 Wh lithium-ion battery for up to 100 miles per charge
- Fast, full charging in 4.5 hours using a standard 110V wall outlet
- Available on over 30 different bicycle brands in North America

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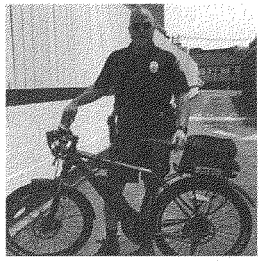
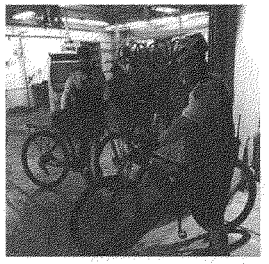
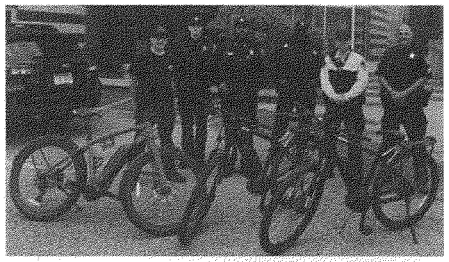
BOSCH

Bosch eBike Systems
Bosch 'n Blue Program

Columbus, OH


Laguna Beach, CA


Tucson, AZ


Detroit, MI & Wayne State University

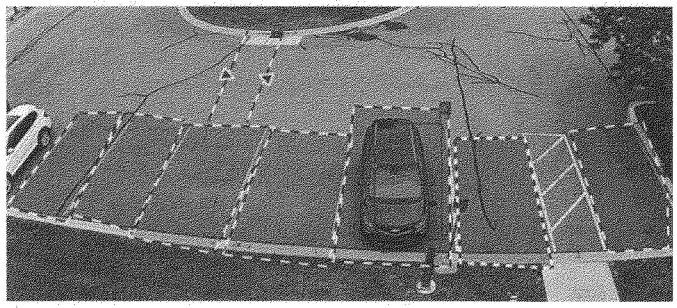
- Over a dozen police departments across the country have taken advantage of what eBikes provide
  - Increased range, higher speeds, incredible flexibility,
- Over 60 test riders (police officers)


Royal Oak, MI

BOSCH

Smart Parking Solution
Key Functionality

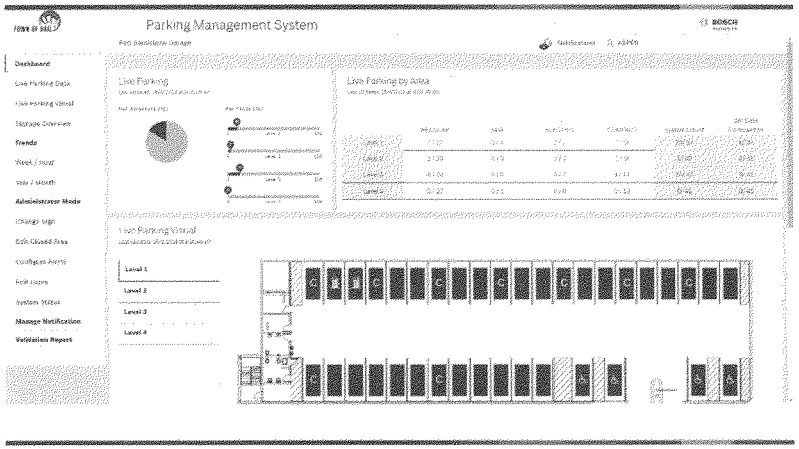
- Parking availability via ground sensors or cameras' on-board intelligent video analytics
- Cameras provide security video and/or vehicle count metadata of parking lanes, decks or lot.
- License plate recognition-based access control
- Parking availability data can be provided to signage or customer specific apps
- Dashboard for visualizing data analytics and parking space management
- Parking Management Software



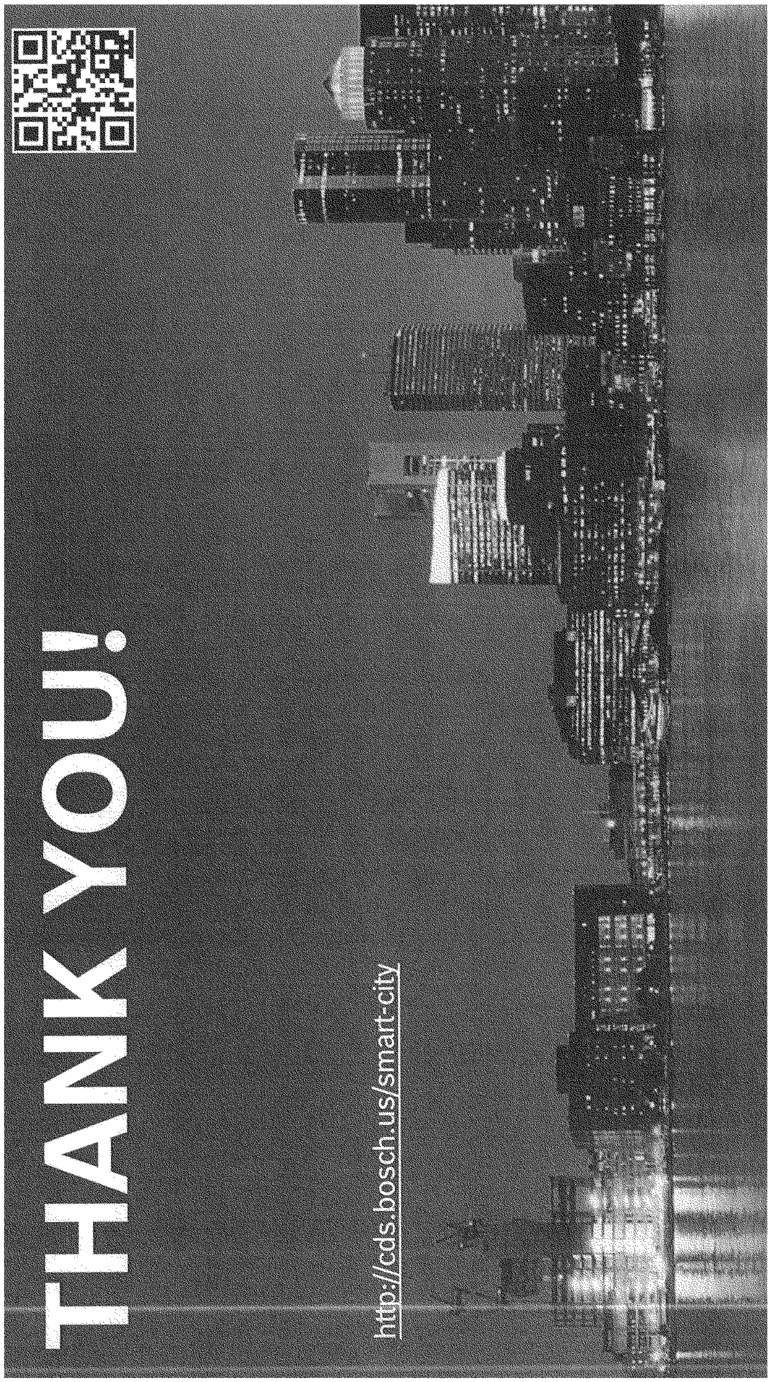
BOSCH

Smart Parking Solution Benefits

- Reduced vehicle traffic and emissions from drivers circling the block looking for a parking spot
- Improved driver experience leading to greater return customers and improved parking spot utilization rates
- Detection and notification of vehicle overstays



- Meta-data stream (object identification /classification) preserves privacy while also reducing back-end communication bandwidth requirements (on-camera edge intelligent video analytics processing compared to full video stream)


THANK YOU!
http://cds.bosch.us/smart-city