U.S. Surface Transportation: Technology Driving the Future
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The University of Virginia Center for Transportation Studies (UVA CTS)

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

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

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

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

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

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

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

MATS UTC

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

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

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

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

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

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

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

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

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

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

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

Federal Involvement in MATS UTC

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

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

State Involvement in MATS UTC

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

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

MATS UTC Advisory Board

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

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

Impact of UVA CTS

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

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

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

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

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

Example of UVA CTS Research Advancing Surface Transportation

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

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

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

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

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

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

Conclusion

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

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