Testimony to the Ohio House Transportation and Public Safety Committee
Hearing on "Autonomous and Connected Vehicles Study"

on behalf of The Ohio State University

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Chairman Green, Vice Chairman Greenspan, Ranking Member Sheehy, and members of the House Transportation and Public Safety Committee:

Thank you for the opportunity to speak this morning in regard to the state of Ohio's autonomous and connected vehicle future. I am here to speak on behalf of The Ohio State University, the state's largest university. Ohio State's faculty, staff, and students are keenly interested in the revolution in mobility that is already underway, in our state and elsewhere. Numerous research programs and innovation initiatives are focused on the broad-reaching implications of this mobility revolution for society, and I am very pleased to be able to tell you a bit about our work in this area.

There is broad consensus that the future of mobility is autonomous, connected, and multimodal. In urban areas, it will be commonplace to see users who employ mobility "packages" that include autonomous vehicles, mass transit, bicycles, and first-mile/last-mile shuttles. Such multimodal packages will be less practical in rural areas, but solutions for both urban and rural areas must be found. This future requires not only smart vehicles but also smart infrastructure—the network of sensors, smart paint, smart lighting, and road and traffic information—with which smart vehicles communicate. Connections from vehicle-to-vehicle will be critical, as will connections to other items in the broader Internet-of-Things. Moreover, to meet the needs of a sustainable future, vehicles will be powered by alternative "green" energy technologies.

Putting all of this in place will depend on rapid development and deployment of technologies and investment in infrastructure across the state.   Ohio's success in this area will depend also on government, industry, and university entities working together in partnership. Ohio State is proud of its record of partnerships with some of the critical entities in mobility. These include our long-standing affiliation with TRC, Inc., an unparalleled proving ground resource; the US 33 Smart Mobility Corridor, where plans to deploy autonomous technology between Marysville and Dublin are proceeding at a rapid pace; industry partners Ford and Honda, with whom we are spearheading a wealth of research and educational initiatives; and the city of Columbus, winner of the US DOT's Smart Cities grant. The collaborative spirit of the region allows us to fully leverage all of these assets to address the issues in making our mobility future a reality.

Ohio State is one of only a few universities in the nation to house 15 colleges in a single location on its Columbus campus. Collaboration is in our DNA, a hallmark of our research and educational programs. This is an important characteristic in the current discussion. The future of mobility presents a series of complex challenges and problems, and a narrowly-focused approach to solutions will surely fail. The university supports and facilitates collaborations in broad programs such as the Discovery Themes initiative, our approach to addressing some of

the world's biggest challenges. The initiative began with aggressive hiring programs in selected topic areas to bring the brightest new talent to Ohio State. As the hiring is completed, the initiative moves into the formation of research centers and institutes to support collaborative research and education. Three of the Discovery Theme areas: Sustainable and Resilient Economy, Translational Data Analytics, and Materials and Manufacturing, are particularly relevant to future mobility. A wealth of new faculty, with innovative ideas and passion, are now focused on issues related to mobility. These faculty integrate with our existing faculty and students to create a powerhouse of new ideas.

The creation of new technologies and their successful implementation and use in Ohio's future must rest on a bedrock of research. The ideas generated by our researchers are the building blocks for future products and services in the mobility sector. I'd like to describe a few of the areas in which our researchers are working to help create the mobility future.

Autonomous, intelligent, and connected vehicles
At Ohio State's Center for Automotive Research (CAR), researchers have been addressing vehicle safety since the 1960s. Work in Intelligent Transportation Systems, with vehicle-to-vehicle and vehicle-to-infrastructure capabilities, began in the 1990s and continues today. CAR engineers have created a fleet of autonomous vehicles for research on automated driving and parking and cooperative adaptive cruise control. Self-driving vehicles engage in intersection access, turning, merging, pedestrian and obstacle detection, and stop-and-go operations to explore the issues that will face future automobiles. First mile/last mile shuttle solutions are actively being pursued.

Alternative fuels and battery storage
Other CAR researchers are addressing the need to create vehicles that are carbon-neutral, to minimize the carbon dioxide emissions that jeopardize our air quality. Vehicles that operate on electricity or use other alternative fuel sources are being developed at CAR. Photovoltaics and fuel cells, as well as hydrogen and compressed gas, are part of the mix. Making these energy sources practicable for everyday and longer-distance use is a central focus of this work. Central to the efforts of this group is creating viable battery energy storage for vehicles, a critical requirement for getting these technologies into the mainstream. For the short-term future, Ohio State researchers are looking at *systems* of charging stations for electric vehicles and their integration into the power grid to ensure better distribution of power where needed across the grid. A microgrid testbed on campus facilitates this work.

Smart infrastructure and transportation modeling
Other work at Ohio State is aimed at the technologies that will create smart infrastructure. Sensor research, pavement-embedded networks, and smart paint are just a few of the areas in which Ohio State scientists and engineers are working. Ohio State's Electroscience Laboratory and scientists across campus are addressing the challenge of collecting and transmitting the information from smart infrastructure to connected vehicles in real time. This work will underlie the development of new products that can be used to create the many miles of smart infrastructure that will be needed for safe operation of autonomous vehicles.

Researchers in civil, environmental, and geodetic engineering are developing transportation system and traffic models for autonomous vehicles. This system-level development is important in designing roadways, entrances and exit ramps, and city streets that can accommodate the needs of an autonomous fleet. In addition, systems that feature unmanned aerial vehicles (drones) and their utility in precision agriculture are being assembled and tested.

Data: dissemination, processing, security, and privacy
The successful deployment of autonomous vehicles on public roads is perhaps most critically dependent on the transmission, reception, and rapid comprehension of massive amounts of data. Ohio State's Translational Data Analytics Discovery Theme brings together researchers

whose interests are focused on how to manage the massive flows of data that will be needed to ensure the safety of occupants, bicyclists, and pedestrians. Novel analytics to compress, organize, and visualize data will be required, and Ohio State's new and established faculty are working to create new analytic techniques.

Equally critical is the need to protect all of this data from unauthorized access and hacking. Cybersecurity solutions will be essential to ensure the safe operation of future mobility. Ohio State is building a presence in cybersecurity to address this overarching issue. Researchers are also addressing issues relating to data privacy and the need to create boundaries governing the use of data in a variety of applications.

<u>The human component</u>
All of this technology is necessary, of course, for our mobility future. But just as important is a consideration of the human response to autonomous, connected, multimodal mobility. This is where Ohio State's collaborative activities are most impactful. Behavioral scientists, legal scholars, logistics experts, biomedical researchers, and policy scholars all team with engineers to ensure that as these technologies are developed, they are usable, appropriate, and trusted by the people who will use them.

In the university's Driving Simulation Laboratory, the reactions of drivers and other vehicle occupants to autonomous and driver-assist technologies are being studied, with the goal of understanding issues related to trust and utility for these systems. In addition, the needs of special user populations, such as older individuals, persons with hearing or visual impairments, and individuals with other cognitive or physical mobility limitations are being investigated, so that future vehicles can be designed to accommodate a wide variety of user needs.

In self-driving vehicles of the future, occupants will likely not need to face forward while traveling. But the safety features of most current vehicles have been developed specifically with regard to occupants seated, facing forward, and belted. Studies of crash bioinjury at Ohio State's Injury Biomechanics Research Center have attempted to predict safety outcomes for "out-of-position" drivers, so that appropriate vehicle safety designs can be created and implemented.

Finally, access to enhanced mobility options for <u>all</u> of the region's residents, regardless of economic status, is an absolute necessity for our mobility future. Ohio State's Center for Urban and Regional Analysis is actively studying the impact of new mobility initiatives on our region's underserved populations, both in cities and rural areas. Additional work on the role of mobility in accessing medical care, both in urban and rural areas, focuses on ensuring that all citizens can rely on public transportation options to get them to needed medical care.

As you can see, Ohio State's faculty, staff, and students are deeply engaged in questions vital to future mobility in the Columbus region and across the state. Working in partnership with the other stakeholders in government and the private sector, we see a bright future for mobility in Ohio. Research and education at Ohio State will help to create this future both by providing the basis for the development of new products and services, and by educating the future workforce talent that will be needed to ensure its success. Working together, we can build a strategy and a plan that will lead to reliable, safe, and effective mobility solutions for all residents of Ohio.

Thank you again for the opportunity to speak to you today on this very important issue.