Testimony of Dr. Chris Urmson, Director, Self-Driving Cars, Google [x]
Before the Senate Committee on Commerce, Science and Technology
Hearing: "Hands Off: The Future of Self-Driving Cars"
March 15, 2016

Chairman Thune, Ranking Member Nelson, and Members of the Committee:

Thank you for inviting me to testify today about the potential for autonomous vehicle technology to improve the lives of people everywhere.

My name is Chris Urmson. Since 2009, I have been leading the technical development of Google's self-driving car technology. I also served on the faculty at Carnegie Mellon University and was previously Director of Technology for the team that won the 2007 DARPA Urban Challenge.

We are grateful for the opportunity to discuss the promise of this technology, including the potential for tremendous gains in safety and productivity. I will share an overview of our work on self-driving cars, including where we currently stand, and some of the lessons we have learned along the way. Perhaps most importantly for this conversation, I will discuss the crucial role that federal policymakers have in enabling the development and deployment of this innovative safety technology for the U.S. public. Today, Congress has a huge opportunity to further this field by enabling the U.S. Department of Transportation to pave the way for the deployment of this innovative safety technology, which will help reduce the more than 6 million traffic accidents that are reported in the U.S. every year.

Google's development and testing of fully self-driving cars

When Google started working on self-driving vehicles over seven years ago, our goal was to transform mobility by making it safer, easier, and more enjoyable to get around. What drives our team is the potential that this technology has to make our roads safer. NHTSA estimates that traffic accidents killed over 38,000 Americans in 2015 and the World Health Organization estimates that 1.2 million lives are lost to traffic accidents globally every year. These are numbers that could be reduced significantly with fully self-driving cars, especially since 94% of accidents in the U.S. are due to human error.

In addition to improving roadway safety, self-driving cars can bring everyday destinations and

new opportunities within reach of those who might otherwise be excluded by their inability to drive a car. For people who are blind, elderly, or living with conditions that would otherwise make driving difficult or impossible, this technology offers the promise of mobility and independence that has never before been available. One woman in Southern California who lost her ability to drive 15 years ago told us, "my life has become very expensive, complicated, and restricted" since she had to start paying drivers and enduring long waits for buses and trains.

The technology also has the potential to reduce current federal spending pressures for roadways, parking, and public transit — all of which were key considerations in this Committee's work on the recently-passed FAST Act. Over the next three decades, the U.S. Department of Transportation expects that self-driving cars will play a key role in reducing transit operating costs, improving highway efficiency, and freeing up existing parking infrastructure (which currently takes up a total area of 3,000 square miles in the U.S., equivalent to the size of Connecticut).[1]

These benefits are closer to being unlocked now that significant portions of the automotive industry are investing in self-driving car technology. In the years immediately following the DARPA Urban Challenge, both government and private sector investments in this technology were extremely limited, but now a wide range of companies across the auto and tech industries — including those testifying on this panel today — are placing bets on self-driving cars.

Between 2011 and 2013 our development efforts focused on autonomous driving for highways by modifying existing vehicles like the Toyota Prius and the Lexus RX450h. Our early tests involved employees driving manually up to a freeway, engaging the autonomous mode, and then monitoring the car until the exit. But in 2013, we decided that to fully realize the safety promise of this technology and serve the most people — even those without a license — our technology needed to be capable of doing all the driving, without human intervention necessary. NHTSA defines this as "fully autonomous vehicles," or "Level 4" on a NHTSA scale for automation established in 2013. Developing a car that can shoulder the entire burden of driving is crucial to safety: we saw in our own testing that the human drivers can't always be trusted to dip in and out of the task of driving when the car is encouraging them to sit back and relax[2] . The Virginia Tech Transportation Institute has measured this phenomenon extensively and found that human operators of partially self-driving cars in a NHTSA-sponsored study took up to 17 seconds to respond to alerts and take control of the vehicle[3].

That's why in 2014, we announced that we were developing a new self-driving vehicle prototype from the ground up — one designed to require no human intervention to get from point A to

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[1] U.S. Department of Transportation, "Beyond Traffic 2045: Trends and Choices," February 2, 2015, <https://www.transportation.gov/sites/dot.gov/files/docs/Draft_Beyond_Traffic_Framework.pdf>.

[2] Google Self-Driving Car Project, Monthly Report, October 2015 <http://static.googleusercontent.com/media/www.google.com/en//selfdrivingcar/files/reports/report-1015.pdf>

[3] National Highway Traffic Safety Administration, "Human Factors Evaluation of Level 2 and Level 3 Automated Driving Concepts," August 2015 <http://www.nhtsa.gov/DOT/NHTSA/NVS/Crash%20Avoidance/Technical%20Publications/2015/812182_HumanFactorsEval-L2L3-AutomDrivingConcepts.pdf>

point B. Exploring what such a vehicle could look like meant making big changes to the features of a car and building in some unique capabilities. For example, we were able to:

- Change the shape of the vehicle so our radar, laser, and camera sensors can be placed for an optimal 360-degree field of view and see as far out as two football fields;
- Build in backup self-driving systems for braking, steering, computing, and more in the event that one of the main systems fails;
- Build in new protections for pedestrians. The front of our prototype vehicles is padded with a special foam-like material that absorbs the energy of an impact, their windshields are made from a flexible material, and their side mirrors are magnetic and easily break away;
- Take out the steering wheel and pedals, as the software is responsible for the driving;
- Bake in defensive driving behavior to avoid having the car get into tricky situations. Our car doesn't get tired, distracted, or angry. They're designed to stay out of other drivers' blind spots, nudge away from lane-splitting motorcycles, and pause for 1.5 seconds after traffic lights turn green to avoid red light runners.

Today, our fleet includes 33 of these prototype vehicles and 23 modified Lexus SUVs. For now, test drivers are aboard all of our vehicles to monitor how the cars drive, and to provide feedback to our engineering team. All our prototype vehicles are equipped with removable steering wheels, accelerator pedals, and brake pedals that allow our test drivers to take over driving if needed while testing.

We have been testing our vehicles on California's public roads for over 7 years, and we recently expanded testing to parts of Austin, Texas, and Kirkland, Washington. So far, we've driven over 1.4 million miles in autonomous mode — that's the equivalent of 108 years on the road, based on a typical American adult driving about 13,000 miles per year.

In our 7 years of testing, we've been involved in 17 minor crashes while driving autonomously. We publish details about the circumstances of every crash on our website, regardless of its severity. While the vast majority of these incidents have been a result of distracted or inattentive driving by other human drivers on the road, we investigate each event and determine whether any improvements to our software and hardware are needed. Using our simulator, we replay and analyze each incident and test our software against hundreds of variations on the same event (for example, we simulate different speeds and positions of other vehicles). We take anything we learn and roll these changes out to our entire fleet.

Testing on public roads allows our cars to experience real, complex scenarios that help us improve our systems. We're also constantly testing, analyzing and evaluating how our software performs in multiple other ways, including on the test track and in our simulator (in which our software drives more than 3 million miles a day).

We look forward to learning how different communities perceive and interact with our vehicles.

We publish monthly reports with summaries of how far we've traveled, new capabilities we're adding, and any accident encountered[4]. Getting people's reactions and feedback is an important part of the learning process. We want to see how people might think differently about a vehicle when it ultimately requires them to do nothing but get in, buckle up, and ride. Educating people about the technology is an important step in building consumer confidence in this life-saving innovation. So far we've found that people find it very mentally freeing and relaxing to just get in and not have to do anything more than press a button.

Federal leadership is needed to enable fully self-driving cars

The federal government plays a pivotal role in setting safety standards for motor vehicles with the powers that Congress vested in NHTSA more than half a century ago. We're encouraged that the Department of Transportation (DOT) has recognized the safety, environmental, and accessibility benefits of self-driving cars. Secretary Foxx has pledged to work quickly with federal and state policy makers to ensure the right policies and guidance are in place to encourage innovation in this field. We welcomed his commitments in January to develop tools, including possible new authorities for NHTSA and DOT, to ensure that self-driving cars can be safely deployed at scale.

The leadership of the federal government is critically important given the growing patchwork of State laws and regulations on self-driving cars. Last December, we were disappointed that California released draft regulations for operation of autonomous vehicles that specifically excluded fully self-driving cars, despite strong public support for this technology, particularly from the disability community. Further, in the past two years, 23 states have introduced 53 pieces of legislation that affect self-driving cars — all of which include different approaches and concepts. Five states have passed such legislation, and — although all were intended to assist the development of the technology in the state — none of those laws feature common definitions, licensing structures or sets of expectations for what manufacturers should be doing. If every state is left to go its own way without a unified approach, operating self-driving cars across state boundaries would be an unworkable situation and one that will significantly hinder safety innovation, interstate commerce, national competitiveness, and the eventual deployment of autonomous vehicles.

As we work toward building a fully self-driving car, having clarity on how existing laws and regulations apply is critical for Google and others working on this technology. In November, Google wrote to NHTSA asking for an interpretation of the existing Federal Motor Vehicle Safety Standards (FMVSS) and how they may pertain to self-driving cars. NHTSA replied to our request for interpretations in early February of this year. Importantly, they agreed that for the purposes of the safety standards, a "driver" in a fully self-driving car can be the self-driving system itself.

[4] *Google Self-Driving Car Project, Monthly Reports, <http://www.google.com/selfdrivingcar/reports/>*

While this clarification from NHTSA was a very positive step forward, it does not change the fact that current regulations — including most of the FMVSS — were written at a time when a self-driving car was nothing more than an idea. In certain instances, these current standards are overly prescriptive in ways that could make a fully self-driving car less safe. In situations where the car is safely making 100% of the driving decisions, having controls that allow a passenger to change its trajectory or operate turn signals or headlamps — for which manual controls are currently mandated in the federal standards — may make the operation of the car less safe. As described above, various studies have documented the hazards of having human drivers "switch back" to the task of driving when they are not expecting it. There are also many federal standards that simply are not needed when a human is not operating the vehicle, such as requirements to include a rear view mirror.

NHTSA's reply to our request for interpretation and its 2017 Congressional budget request both highlighted that "[n]ew authorities may be needed when they are necessary to ensure that fully autonomous vehicles, including those designed without a human driver in mind, are deployable in large numbers when demonstrated to provide an equivalent or higher level of safety than is now available."

We strongly support NHTSA's goals and believe that Congressional action is needed to keep pace with safety technologies being developed by vehicle manufacturers and technology innovators, including fully self-driving cars.

To achieve this goal, we propose that Congress move swiftly to provide the Secretary of Transportation with new authority to approve life-saving safety innovations. This new authority would permit the deployment of innovative safety technologies that meet or exceed the level of safety required by existing federal standards, while ensuring a prompt and transparent process.

We look forward to working with this Committee, DOT, and NHTSA to ensure that this type of new authority can effectively achieve the safety and innovation benefits of fully self-driving cars. We also believe that these policy-setting opportunities will help continue U.S. leadership on this technology for the years ahead.

Conclusion

In the coming years, we'd like to explore driving in other cities that can teach us about different types of challenging weather and terrain. We'd also like to run pilot programs to learn what people would like to do with fully self-driving vehicles. If the technology develops as we hope, we'll work with partners to bring this technology into the world safely.

The importance of getting self-driving car technology safely into people's hands is best summed up by those who most need it. During a recent California DMV workshop to discuss the technology, regulators heard from Justin Harford, a man who is legally blind. Justin said: "what

this is really about is who gets to access transportation and commerce and who doesn't and I'm frankly tired of people with disabilities not being able to access commerce."

Our team at Google believes that self-driving cars can ultimately remove these transportation barriers from our society. Thank you for your help in creating a path for this technology and for your time and consideration today.