U.S. House of Representatives
Committee on Transportation and Infrastructure
Subcommittee on Highways and Transit
Wednesday, September 13, 2023

Chairman Graves, Ranking Member Larsen, Chairman Crawford, Ranking Member Holmes-Norton, and Members of the Subcommittee on Highways and Transit. Thank you for the invitation to provide testimony for the hearing "The Future of Automated Commercial Motor Vehicles: Impacts on Society, the Supply Chain, and U.S. Economic Leadership."

My name is Chris Urmson and I am the CEO and Co-founder of Aurora. I have twenty years of experience leading automated vehicle programs, which started when I was the Director of Technology for Carnegie Mellon's DARPA Grand and Urban Challenge Teams in Pittsburgh, Pennsylvania. After the DARPA Challenges, my family and I moved to California where I helped found and lead Google's self-driving car program (now Waymo). In early 2017, I co-founded Aurora with Sterling Anderson and Drew Bagnell.[1] I have been issued over 150 patents and have authored over 50 publications. I earned a PhD in Robotics from Carnegie Mellon University and a Bachelor of Science in Computer Engineering from the University of Manitoba.

As we celebrate National Truck Driver Appreciation Week, we recognize the essential role truck drivers play in today's supply chain and we are excited about the opportunity to showcase our vehicle operators' excitement and enthusiasm for autonomous vehicles (AVs) and their impact on our communities, and future generations to come.[2] I'd like to take this opportunity to thank all truck drivers for their dedication, commitment, and the many challenges they overcome to ensure that our goods are delivered safely, securely, and on time.

About Aurora

Aurora is a publicly-traded American company with the mission to deliver the benefits of self-driving technology safely, quickly, and broadly. We are building the Aurora Driver: a platform that brings together software, hardware, and data services, to autonomously operate any vehicle without the need for a human operator in the vehicle. Aurora has offices across 8 cities in 7 states, including our headquarters in Pittsburgh, Pennsylvania, and employs 1,800 people ranging from hardware and software engineers to commercial drivers and operations specialists.

The Aurora Driver can power a variety of diverse vehicle platforms, from Class 8 trucks to passenger vehicles. The Aurora Driver runs on a robust, proprietary computer that enables powerful software to understand complex environments and safely control the

[1] https://ir.aurora.tech/company-information/leadership-team
[2] Future of Freight: Leveraging Industry Expertise to Safely Deploy Autonomous Trucks

vehicle through them. It incorporates high-resolution radar, lidar, and camera data that allow it to simultaneously see and track objects around the vehicle, giving it deep familiarity with the ever-changing, surrounding world.

Aurora has deep collaborations with truck OEM partners that will be critical to bringing autonomous technology to market. We have strategic partnerships with two of the top three truck OEMs that collectively produce about 50% of the trucks sold in the U.S. market.[3] Aurora has long-term commitments to build and deploy self-driving trucks at scale with these partners, and all parties are making significant investments in the success of the programs — both with capital and with experience and skill.

As Aurora continues to hit milestones[4] and prepare for the commercial launch of our Aurora Horizon[5] autonomous trucking service, we are keeping our industry-leading safety approach at the forefront of development and deployment. Because the focus of this hearing is commercial trucking, my written comments are focused on Aurora's activities and efforts around heavy duty trucks.

The Importance of Autonomous Trucking

The United States lost over 42,000 Americans on our roads last year.[6] Two million Americans are injured in vehicle crashes each year which puts strain on families, our health care system, law enforcement resources, and the workforce.[7] We believe that the public and private sectors should be using every tool in the toolbox to address this public health crisis.

Specific to trucking, there are approximately 500,000 truck crashes each year and the U.S. saw approximately 5,800 fatalities in large truck accidents in 2021, a 17% year-over-year increase.[8] In the U.S., trucking accounts for 195 billion vehicle miles traveled (VMT) annually, is 65 percent of total goods movement,[9] and is a $700 billion segment of the U.S. economy.[10]

Innovation is imperative for the continued health of the trucking industry and for the U.S. to remain globally competitive. Autonomous trucks will help support manufacturers and retailers with the safe movement of goods. We expect AVs to dramatically reduce the rate of crashes and injuries on our roadways over the long term, which in turn will reduce pressure on local emergency responders and health care systems. The tremendous potential benefits

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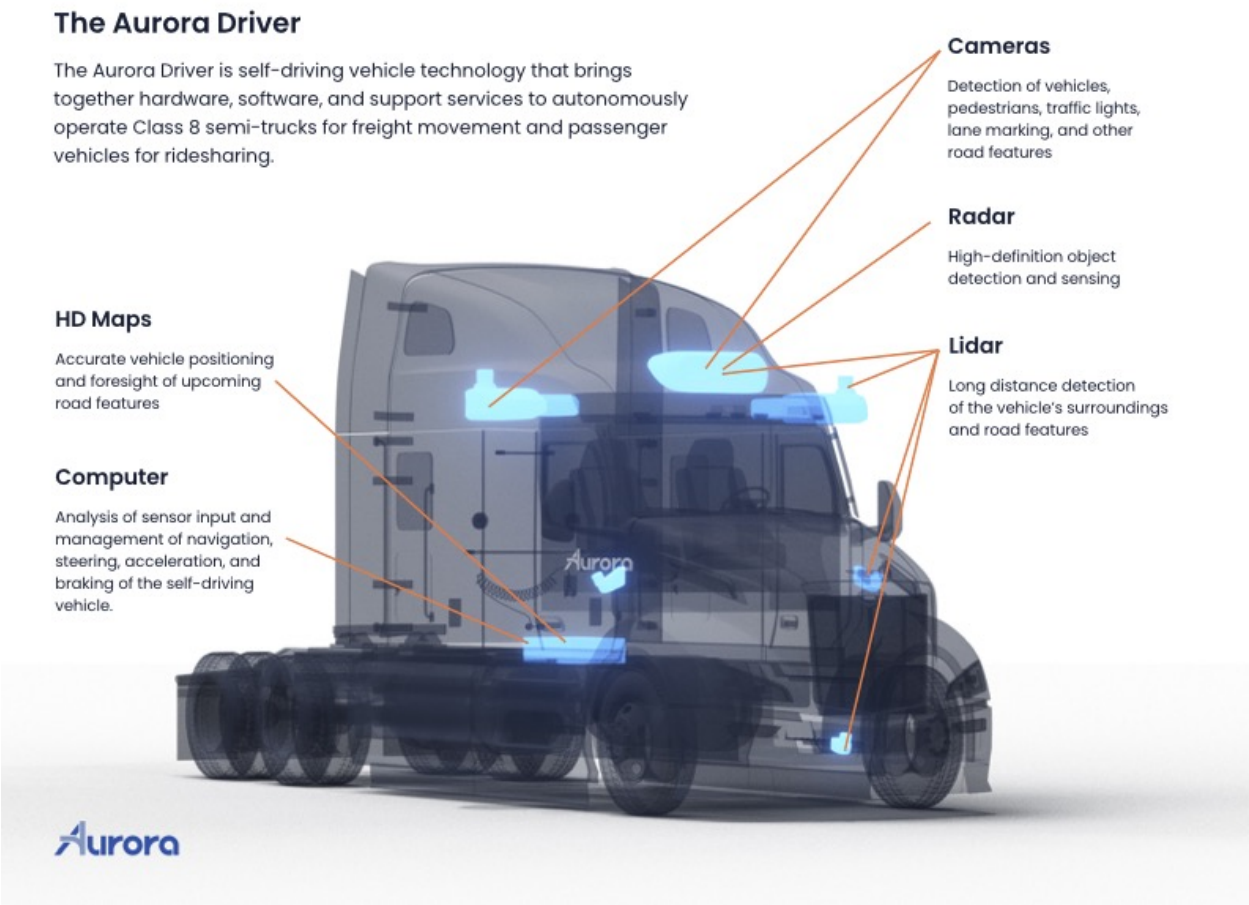
[3] https://d1io3yog0oux5.cloudfront.net/_cb99f486f1d34eb2c6df028273f8ba29/aurora/db/856/7880/pdf/Investor+Presentation+-+August+2023.pdf
[4] https://blog.aurora.tech/products/the-aurora-driver-is-feature-complete
[5] https://aurora.tech/aurora-horizon
[6] 1.3 million people die per year in road fatalities (WHO 2022); https://www.nhtsa.gov/press-releases/traffic-crash-death-estimates-2022.
[7] https://www.google.com/url?q=https://www.cdc.gov/vitalsigns/motor-vehicle-safety/index.html%23:~:text%3DHowever%252C%2520more%2520than%252032%252C000%2520people,year%2520from%2520motor%2520vehicle%2520crashes&sa=D&source=docs&ust=1694382628750727&usg=AOvVaw0bjxQBNSVPvutJwCDFQBVD
[8] National Highway Traffic Safety Administration (NHTSA) 'Traffic Safety Facts: Large Trucks' Revised June 2023
[9] Trucking accounts for 300B miles annually (BTS 2020) and moved 65% of goods by weight in 2017 (BTS 2017)
[10] A.T. Kearney State of Logistics, 2020.

of autonomous technology are apparent to many in the supply chain. For example, in California, we're seeing a diverse group of stakeholders—from former law enforcement officers and safety organizations to small business owners, suppliers, and manufacturers—all supporting the continued development of this technology at recent public hearings.

The Aurora Driver



Aurora uses sensor fusion from a combination of lidar, radar, and cameras to give the Aurora Driver a near 360° view of its environment. This fusion of different sensor types allows the Aurora Driver to leverage the best of what each sensor can provide, allowing the technology to see at long ranges and in poor weather conditions. At the heart of this sensor technology is our industry-leading proprietary FirstLight lidar, which is able to track and detect objects greater than 400 meters away while simultaneously measuring their speed. Seeing and being able to nearly simultaneously interpret what those actors are doing at this distance allows for quicker reaction time and safer motion planning, which is critical when moving at highway speeds. We collect and use sensor data from our vehicles to build our maps, train our system, and continuously improve our technology.

Aurora's Investment in Partnerships

We are continuing to build a powerful ecosystem of the world's leading trucking, automotive, and logistics companies to bring the promise of autonomous trucking to market. Our work with our truck OEM partners, PACCAR and Volvo Trucks, and our new Hardware as a Service partner, Continental, continues to progress as we prepare for Commercial Launch and beyond.

In order to operate at scale our technology needs to withstand challenging durability requirements while installed on a truck. For example, during the second quarter of 2023, PACCAR completed a 1.5 million equivalent mile durability test of a Kenworth cab with the Aurora Driver hardware installed. The Aurora Driver hardware remained fully functional at the end of the test.

Volvo Autonomous Solutions and Aurora expect to begin testing an autonomy-enabled prototype Volvo truck powered by the Aurora Driver in the first quarter of 2024. Separately, Volvo Autonomous Solutions has expanded its footprint in North America with the establishment of an office in Texas and started manual operations in preparation for the commercial launch of its autonomous hub-to-hub transport solution, powered by the Aurora Driver.

In April, we announced a long-term partnership with Continental to develop, manufacture, and service a commercially-scalable future generation of the Aurora Driver's hardware kit. Continental has already started development efforts to scale the Aurora Driver. In addition, the partnership's Hardware as a Service structure will enable Aurora to pay for the hardware on a per mile basis. This structure is a first-of-its-kind for this industry and aligns with and supports our Driver as a Service business model.

The model also drives significant value-alignment between, Continental, our customers, and ourselves. We believe industrializing our hardware kit through this partnership will help us achieve the commercial scale and cost structure necessary to support our long-term profitability objectives.

Aurora's Commitment to Safety

Risk is inherent in everything people do. Even the most common, frequent tasks we undertake, from taking a shower to driving around town, have inherent risk. With this in mind, humans have developed means of mitigating those risks—our showers are designed to have anti-slip surfaces and our vehicles have seat belts, airbags, and other safety equipment. While these safety controls do not eliminate the risk entirely, they help ensure the activities we complete every day are acceptably safe—meaning risk is mitigated enough that we can complete everyday activities without posing significant risks to ourselves or those around us.

This applies to developing vehicles as well, autonomous or otherwise. At the end of the day, after we have completed all of our objectives, double- and triple-checked our work, and verified and validated the results, there will always still be some degree of residual risk. When developing the Aurora Driver, we've implemented our Safety Case Framework to show that we're mitigating risk across a wide variety of claims that encompass our product, operations, and organization—enabling partners and customers to know our technology is acceptably safe for public road operations. This work is discussed further below in our learnings from operations on Interstate-45 in Texas.

We take a holistic view of safety, focusing on creating a strong safety culture that permeates every part of our company, including how we do business.[11] A key part of that approach to safety is implementing our Safety Management System, commonly referred to as SMS. This is an organizational approach—employed by safety-critical industries like aviation and rail—that standardizes how safety information moves through a company.

SMS ensures that safety information is presented to the right person, at the right time, and that there is accountability and transparency for every safety action taken across the company. This approach ensures that safety is prioritized as we make decisions, with features such as a Safety Review Board for safety risk management decisions and a clear and easy-to-use Safety Concern Reporting process, both described in detail below.

At Aurora, we are building our SMS on four key components—a detailed Safety Risk Management structure, a robust Safety Assurance program, disciplined Safety Policy documentation, and an engaging Safety Culture that includes safety education and events. Our SMS helps ensure we're proactively identifying safety issues and resolving them as early as possible. It also ensures our entire company values safety, understands our safety procedures, and is using a common language to talk about risk.

We actively work to make safety a part of everyday life at Aurora. For example, our non-retaliation Safety Concern Reporting policy encourages everyone at the company, from our vehicle operators to our C-Suite, to speak up if something doesn't feel safe.

[11] https://aurora.tech/vssa

We also leverage experts inside and outside of Aurora. Our Safety Review Board, an internal group of cross-functional leaders, meets regularly to address active safety issues. And we engage regularly with the Aurora Safety Advisory Board, made of external experts from fields including aviation safety, insurance, emergency/trauma medicine, automotive safety, and academia.

Aurora Safety Advisory Board Members:

- Dave Carbaugh, Former Chief Pilot Flight Operations, Boeing
- Adrian Lund, Managing Member of HITCH42, LLC and former President of the Insurance Institute for Highway Safety
- Dr. Victoria Chibuogu Nneji, Lead Engineer & Innovation Strategist at Edge Case Research
- Dr. Jeff Runge, President of Biologue, Inc. and former Administrator of the National Highway Traffic Safety Administration
- George Snyder, President and CEO of GHS Aviation Group
- Karen Rasmussen, Executive Director of the Independent Carrier Safety Association (ICSA)

Safety Case Framework

How do we know if an AV is safe enough to drive on public roads? It's a question that continues to be asked particularly since this technology has been tested on public roads for almost a decade. At Aurora, our answer is to use a safety case approach to evaluate if our vehicles are acceptably safe to operate on public roads and not create an unreasonable risk to roadway safety.

Safety cases are not a new concept. Our safety case framework is based on the best practices of other industries and on industry standards. They have been widely used in other safety-critical industries like aviation, rail, and medical devices, and have been referenced in AV industry standards, such as UL 4600.

In August 2021, we publicly released Aurora's Safety Case Framework—the first AV Safety Case Framework that applies to both autonomous trucks and passenger vehicles. We believe that a Safety Case Framework is the most effective and efficient path to safely operating without a person onboard the truck and is an imperative component for any company looking to safely deliver commercial-ready AVs at scale. We are the only AV company currently operating in our industry to publicly share its Safety Case Framework and its associated claims.

Building a Safety Case Framework allows us to demonstrate exactly how we are approaching safety and the many factors we are taking into consideration—a stark contrast to simply reporting on miles driven or disengagements, which do not necessarily provide support to demonstrate that a vehicle is safe for any specific context or environment. Our structured approach of defining claims and providing evidence about our technology and operations is the only way Aurora believes we can safely commercialize our AVs.

A structured safety case argument includes a specific claim—e.g., that our self-driving vehicles are acceptably safe to operate on public roads—that is then distributed into multiple levels of subclaims that are supported by evidence. For example, if we make a claim that we can sufficiently maintain and service our self-driving vehicles, then supporting evidence could include our maintenance requirements, procedures, and guidelines and logs.

Along with delivering a safe product, being transparent with our approach is an important part of developing autonomous technology. Our top-level claim, that the Aurora Driver is acceptably safe to operate on public roads, is broken down into the following five safety principles:

- Proficient
- Fail-Safe
- Continuously Improving
- Resilient
- Trustworthy

1. **Proficient** - An AV cannot be considered safe to operate on public roads unless it is suitably proficient. Proficiency includes the design, engineering, testing, and requirements for nominal operations and performance.

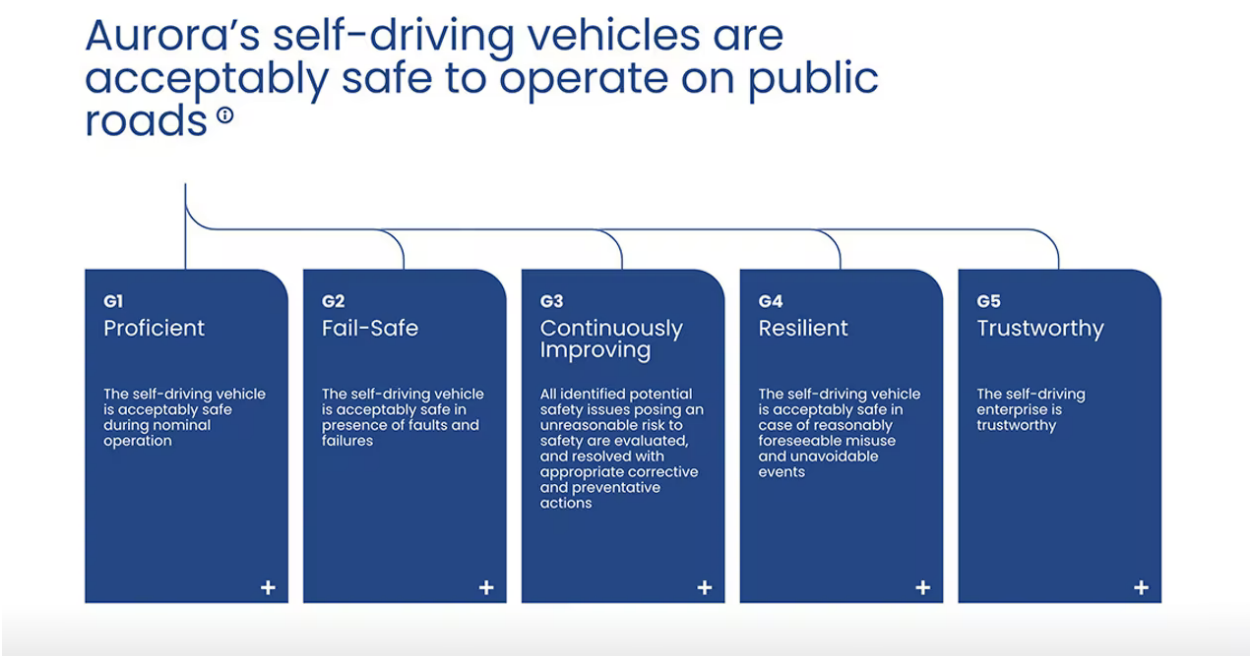
2. **Fail-Safe** - The fail-safe principle addresses how the AV behaves in the presence of faults and failures. No system is ever 100% reliable; components will wear out or have premature failures from time to time. This principle ensures that the Aurora Driver safely mitigates these failures.

3. **Continuously Improving** - The continuously improving principle outlines how we are enshrining the concept of continual improvement into the development of our system. Field data feeds a comprehensive data analysis effort that calculates safety performance

indicators and also considers data collected during design and development. Aurora also takes a proactive approach to continuous improvement, using risk identification techniques to proactively identify and manage risks.

4. **Resilient** - AVs are designed to safely operate on public roads, but this does not isolate them from malicious actors or unavoidable events. The resilient principle requires evidence that demonstrates that our system is capable of withstanding adverse events and intentional misuse and abuse. For example, our cyber-security-related claims mostly reside under this principle and are discussed further below.

5. **Trustworthy** - An AV may be claimed to be Proficient, Fail-Safe, Continuously Improving, and Resilient, but without the trust of the public and governmental regulators, it cannot fully realize the top level claim. The trustworthy safety principle addresses how we gain trust through public, government, and stakeholder engagement. We further emphasize safety transparency, safety culture, as well as external review and advisory activities.



Aurora will not launch our autonomous trucking product until our safety case for initial driverless operations is complete. We see this as the highest safety bar in our industry, and one that helps ensure our complete product (including software, hardware, and data services) and our company, are ready for commercial operations.

The Aurora Driver will be ready to launch when we have a closed Safety Case for our Dallas to Houston lane. It goes beyond just ensuring the vehicle drives well enough for a demo; rather, it demonstrates that our product, and our company, are holistically and sustainably safe.

Cyber-security

Securing an AV against cyber-security risks requires diligence throughout its development and operation. A secure system is one that minimizes architectural weaknesses and is ready to respond and recover from identified risks.

Aurora's security architectural approaches are motivated and measured through integration into Aurora's Safety Case. Leaning on the Safety Case and security principals, Aurora has developed an extensive and adaptive security approach, aligned with best practices and standards, to secure the extremely varied component ecosystems that compose an autonomous system. We consider all functional areas of our technology to be potential targets with different threat models, and, therefore, a potential vehicle safety concern.

Aurora has adopted security architectures and risk-based assessment methodologies that derive and measure security controls through two major themes —"Trust the Operation of the Aurora Driver" and "Detect, Respond, and Recover." These two major themes are comprised of six narratives that are addressed cross functionally with our partners and across the company.

- Build, Deploy, and Activate Securely
- Trusted Startup
- Engage Autonomy
- Trusted Off Board Actions
- Identifying privileged access
- Security detection and response

These narratives, and the controls they derive, serve as a blueprint for the components that must be assessed along with the relative depth for each. Inspired by guidance from the National Institute of Standards and Technology (NIST),[12] the National Highway Traffic Safety Administration (NHTSA), and industry groups, this approach enables Aurora to address security from both a product and process perspective, as well as providing defense in depth through layered controls.

Cyber-security risks are constantly evolving, so continuous improvement in handling them is critical. By proactively exploring risks, investing in solutions, and collaborating with our industry partners,[13] we regularly incorporate security upgrades across our fleet in order to harden them against threats. We are dedicated to advancing security approaches and

[12] NIST Special Publication 800-160 v2 Developing Cyber-Resilient Systems: A Systems Security Engineering Approach, 2021; ISO 21434 Road vehicle — Cybersecurity engineering, 2021; NHTSA Cybersecurity Best Practices for the Safety of Modern Vehicles, 2022.
[13] https://avsc.sae-itc.org/

capabilities within all components to improve the security posture for future self-driving vehicles across the industry.

Building and Learning on I-45 and Beyond

Today, Aurora Driver-powered Class 8 trucks (under the supervision of vehicle operators) support commercial operations between Dallas and Houston and between Fort Worth and El Paso. We plan to launch our driverless commercial operations on the Dallas to Houston lane on I-45 next year. In time, as we continue to mature, we look forward to expanding into new geographies to support our freight customers.

But let me be very clear: before a driverless Aurora Driver-powered vehicle touches a new lane, we will ensure that our safety case encompasses operation in that new environment. Moving into new geographies is something we will continue to do thoughtfully. In addition to understanding which claims in our safety case will need new evidence, we will also do the following:

We begin by mapping. We build our own high-definition maps, which contain detailed information about road infrastructure, geometry and lanes, and other geometric information. We build these maps automatically from data our vehicle collects and then augment that with human annotations of important road elements such as lanes, stop signs, and traffic lights on top of the world geometry.

Think about these as layers of data, which help our software system understand the world around it across three fronts:

1. Localization, which determines the vehicle's position relative to the map by matching the stored geometry data with what the sensors identify in real time;
2. Perception, which uses the geometry and annotations to allow the Aurora Driver to perceive other road users; and
3. Motion planning, which uses the annotations to prepare for maneuvers like turns and stops.

Importantly, when the Aurora Driver encounters changes in the real-world, on-road environment, they can be shared with our Aurora-powered fleet of vehicles.

With the map in hand we model and test any novel on-road scenarios or regulatory requirement unique to this new lane in simulation. There is a limit to how much meaningful data can be gathered through test tracks and on-road driving. Aurora has invested heavily in the development of a proprietary, highly accurate, and scalable Virtual Testing Suite. These tests become part of the evidence for the Proficient pillar of our expanded safety case.

With a map and an expanded and now closed safety case, we would then be ready to safely deploy the Aurora Driver on the new lane.

Aurora's Virtual Testing Suite

Aurora's Virtual Testing Suite enables us to repeatedly expose the Aurora Driver to common and rare on-road scenarios. And from virtual testing, we can understand how the Aurora Driver performs in millions of scenarios. Over time, new, interesting events are captured and added to our simulation database, where they are used to continually improve the system.

Aurora's Virtual Testing Suite makes it possible to amplify exposure to these events to test the Aurora Driver's performance in those scenarios.

We do this in two ways:

- First, important but rare on-road events the Aurora Driver has encountered are turned into simulation tests. We then create variations to further challenge the system's performance in these scenarios.
- Second, for events so rare the Aurora Driver has not experienced them on the road, we synthetically generate simulation tests using the established NHTSA collision categories, which enumerate the ways vehicles crash.

For these imminent collision scenarios and rare on-road events the Aurora Driver has encountered, we are creating tens of thousands of tests.

Similar to the expected performance of a human driver, the Aurora Driver is being designed to avoid a collision if possible, and if a collision is not avoidable—such as in scenarios where another actor's behavior renders a collision inevitable—the Aurora Driver is designed to mitigate adverse outcomes. Success of these tests will give us the conviction that the Aurora Driver is designed to do the right thing in these rare scenarios.

In addition to evaluating the Aurora Driver in imminent collisions, we also looked at the available fatal collision details that involved a tractor trailer between the years 2018 and 2022 on our Dallas to Houston lane.

- We simulated those collisions to understand how the Aurora Driver would have acted under similar circumstances if it had been the initiating vehicle.
- Based on our analysis, we believe that had the Aurora Driver been driving, the combination of its powerful sensor suite and attentive driving behavior would have prevented these collisions.

Said simply, if the Aurora Driver had been driving the vehicle, none of these fatal collisions would have occurred.

Workforce Development

Aurora's commercial-ready terminal in Palmer, Texas,[14] and our growing Command Center are great examples of how the AV industry will create new workforce opportunities across the country. Our terminals provide services necessary to operate and scale self-driving fleets, including fueling, weigh stations, on-site maintenance, sensor calibration, and more, while our Command Center supports vehicles through dispatch, remote assistance, incident response, and asset management functions. These functions will support safe operation of trucks on the road, help optimize fleet uptime, and, crucially, involve a range of new jobs.

Aurora has already created many new roles to support autonomous trucking technology and its scaled deployment, including:

- Terminal Operators who handle tasks within the terminals, including pre- and post-trip inspections, transfers and management of trailers, and logistics management.
- Fleet Support Technicians—the "Mechanics of the 21st Century"—who maintain autonomous trucks' sensors and systems and maximize vehicle uptime.
- Command Center Specialists who, among other things, provide remote assistance and advice to the Aurora Driver when it comes across something unexpected on the road and needs guidance, like an unmapped road closure.
- Fleet Dispatch Specialists who manage AV fleets and help ensure availability for customers.
- Autonomous Vehicle Operations Specialists with commercial driver's licenses (CDLs) who support the testing and validation of our autonomous trucks and passenger vehicles. These specialists will be essential in the coming years as we continue to develop and validate new capabilities for the Aurora Driver.
- Mapping Quality Specialists who process and triage map issues, including improving tooling for scalability of high-definition maps.

Aurora has cross-trained a number of its existing workforce to transition into many of these critical roles, and we're working with local communities and academic institutions to build this workforce.

Demonstrating our commitment to workforce development, Aurora has worked with Pittsburgh Technical College to design an associate degree program that trains and accredits Fleet Support Technicians, giving them the tools they need to maintain AVs and

[14] https://ir.aurora.tech/news-events/press-releases/detail/67/aurora-debuts-industry-leading-commercial-ready-terminal#:~:text=Aurora's%20South%20Dallas%20terminal%20was,is%20in%20commercial%20use%20today.

support operations. This complements work with Gallatin College in Bozeman, Montana, where Aurora is investing in new educational facilities to train sensor technicians and develop advanced lidar sensors. As the need for these professionals grows, academic degrees, technical training programs, and apprenticeships will be essential in building the workforce of the future.

Aurora is also supporting the Headwaters TechHub application submitted by a consortium of leaders in Montana to support the development of the photonics industry in the United States.[15] Specifically, Aurora has committed to collaborate with Montana State University (MSU) to operate a lidar test range; build a new 78,000 square foot facility in Bozeman, Montana, where Aurora will use a portion of the space to continue to grow our team and produce future generations of Aurora's FirstLight Lidar to support our expanding fleet of commercial AVs; and offer expertise for potential workforce development efforts based on the Gallatin College Photonics Program.

We ask Congress to ensure that commissioned research about the job-related impacts of AVs be driven by actual industry experience, and that job quality should be central to any policy and industry conversation. It is encouraging that a 2021 USDOT report indicated that potential reductions in long-haul trucking jobs related to AVs are likely to be offset by natural occupational turnover instead of layoffs.[16] Testing and deploying AV technology is a key component of ensuring there are real world models to ground these important conversations as we continue to learn more about new and transitioning jobs.

Government Engagement

Aurora's engagement with all levels of government is a key component of the Trustworthy Principle in our Safety Case Framework. In this testimony, two examples will be discussed further: federal data reporting requirements and examples from our engagement with Texas.

USDOT Reporting and Publicly Available Data

Aurora takes part in two federal safety-related data reporting mechanisms. First, NHTSA's Standing General Order (SGO) for Crash Reporting for Incidents Involving Automated Driving Systems (ADS) and Level 2 Advanced Driver-Assistance Systems (ADAS). Second, the Federal Motor Carrier Safety Administration's (FMCSA) Safety and Fitness Electronic Records (SAFER) database system for motor carriers.

Under NHTSA's SGO, all AV manufacturers and operators, including Aurora, are required to report to the Agency certain crashes in which an ADS was engaged at any time

[15] https://www.tester.senate.gov/newsroom/press-releases/tester-urges-department-of-commerce-to-select-montana-application-for-regional-tech-hub-designation/

[16] "Macroeconomic Impacts of Automated Driving Systems in Long-Haul Trucking," Jan. 28, 2021, FWHA-JPO-21-847, https://rosap.ntl.bts.gov/view/dot/54596.

within 30 seconds of the crash and the crash resulted in injury or property damage. NHTSA has made this data publicly available at regular intervals since the SGO was first released in 2021. The public can access and use this information to understand when and where crashes involving AVs have occurred without needing to contact the local or state authorities of the jurisdictions in which the AVs operate. Aurora submitted comments to NHTSA in 2021 describing how the Agency could improve the SGO's definitions and data collection requirements to ensure that the Agency receives targeted and actionable data regarding the safety of ADS operations. In addition, Aurora's comments provided suggestions to help ensure the public has accurate and reliable information regarding AV safety by aligning the SGO's terminology with the congressionally mandated TREAD Act early warning reporting regime already applicable to manufacturers.

Aurora has reported three collisions to NHTSA under the SGO. In the case of the collision we experienced in April of this year, a passenger vehicle sideswiped one of our Aurora Driver-powered trucks on the freight route between Fort Worth and El Paso. As the event unfolded, the Aurora Driver detected the incoming vehicle and began to move away from it by entering the shoulder of the road, in autonomy. The passenger vehicle continued to veer toward our truck at over 65 miles per hour, causing a collision. The Aurora Driver detected the imminent collision and our onboard vehicle operator took control of the truck, safely decreased speed, and pulled over. When deployed without a vehicle operator, the Aurora Driver is designed to execute this response autonomously while the Aurora Command Center contacts first responders.

After confirming the safety of our team, we immediately shared information about the incident with law enforcement, partners, and regulators, including Texas Department of Transportation (TXDOT) and Department of Public Safety (DPS). All of these actions align with our organizational preparation for scenarios like this, and as part of our commitment to transparency, we shared information about the event with the public on our blog[17] in April.

In November 2022, we reported an incident to NHTSA in which a piece of wood was kicked up into our vehicle's windshield after going under the wheels of a truck to the left side of the Aurora truck, while the Aurora truck was in manual mode. The vehicle's windshield cracked but did not shatter. On July 18, 2023, an Aurora Class 8 truck was traveling southbound in autonomy mode on Interstate 45 near Exit 164 when the front windshield was struck by an unknown object. The bottom of the windshield had a small hole. The Aurora vehicle disengaged autonomy and pulled over. The vehicle was able to be driven from the scene, and there were no reported injuries.

FMCSA's SAFER system provides the government and the public with a concise electronic record of motor carrier safety data. By accessing the system, a user can obtain an electronic record of a company's identification, size, commodity information, and safety record, including the safety rating (if any), a roadside out-of-service inspection summary,

[17] https://blog.aurora.tech/safety/stories-from-the-road-safety-readiness-case-studies

and certain crash information. For example, through the SAFER system, a user can quickly see that Aurora has 46 registered power units (tractors) and 49 employed drivers, Aurora's operating status and classification, and the types of cargo Aurora hauls, among other information.[18]

Snapshot from Texas

Aurora believes that active communication with government agencies and communities at the national, state, and local level is an important aspect of our development and commercialization. Before Aurora started operating our vehicles on Texas roads, we engaged with TXDOT and TXDPS, and we have since briefed these agencies' staff at a regular cadence regarding our activities and planned expansion in the state. In addition, Aurora is a member of TXDOT's Connected and Automated Vehicle Task Force, which is composed of members from TXDOT, local governments and transportation officials throughout Texas, community members, Texas academic institutions, and industry. The task force regularly publishes industry updates to keep stakeholders informed about advancements in the technology. Separately, Aurora supported TXDOT's study on AVs required by Texas Senate Bill 1308 by participating in numerous workshops and providing presentations to stakeholders about how our technology works, our Texas operations, and how our technology will fit into the broader Texas transportation system.

Aurora also engages with government agencies and officials of the local jurisdictions in which we operate. In Texas, Aurora has met with the City of Dallas Transportation Director and has presented at a Border Trade Advisory Committee meeting in El Paso, which included the El Paso mayor and county commissioners and other elected officials. Aurora also notifies and works with local law enforcement agencies of the jurisdictions in which we operate. For example, we communicate with the City of Palmer Police Department, and we have contacted agencies in other local jurisdictions where we open new terminals.

Aurora has developed and shared Law Enforcement Interaction Plans (LEIPs) with our stakeholders to ensure they understand where, when, and how our vehicles operate so that if they do encounter them, they know how to safely interact with them. Aurora's current LEIPs are designed for interactions with our vehicles and vehicle operators, and we will release new versions when we have determined the Aurora Driver is acceptably safe to operate autonomously without human vehicle operators.

Federal Policy

There are opportunities for the federal government to support the development and deployment of AV technology in the United States, providing certainty that companies, including

[18] In addition to the publicly available SAFER system, motor carriers are also required to maintain, and produce to FMCSA or authorized enforcement agencies upon request, an accident register of all crashes involving the motor carrier that have occurred in the past three years. 49 CFR 390.15.

Aurora, continue to invest and build here.[19] Creating a level playing field where the rules are clear and conducive to realizing the safety, mobility, and efficiency benefits of AV technology is a necessary role of government.

Aurora supports the work of Members of this Committee, Congress, and the U.S. Department of Transportation (USDOT) to ensure that laws and regulations for AVs are performance-based and technology and business-model neutral.

Federal leadership supporting the development of AV technology here in the United States is critical. The work that started many years ago at USDOT under Secretary Foxx, continued under Secretary Chao, and carries through today under Secretary Buttigieg. USDOT's guidance, research, and rulemakings that have been initiated specific to AVs, along with the Department's use of its convening authority to bring stakeholders together, has laid the foundation for the future and there is still more work ahead.

Modernizing Regulations

We support NHTSA's efforts to modernize the Federal Motor Vehicle Safety Standards (FMVSS) and the FMCSA's efforts to modernize the Federal Motor Carrier Safety Regulations (FMCSR) to encourage the development of new and innovative AV technologies.

As you know, the FMVSS and FMCSR were not created with autonomous technology in mind and neither wholly contemplated the integration of autonomous technology, like the Aurora Driver, into vehicles. These frameworks, therefore, should be updated to account for this new technology as appropriate to provide regulatory certainty for developers of this technology and to improve the efficiency of its deployment. There are important open rulemakings at NHTSA and FMCSA[20] that need to continue to move forward. In preparation for other future regulatory actions, the agencies should continue providing guidance, conducting research, and fostering collaboration among stakeholders to support AV development. Additionally, existing exemption processes at USDOT should be used as a bridge to generate real-world data about innovative vehicle technologies that could inform future rulemakings that support AV deployment.

A timely example for the Subcommittee is the warning device exemption application filed with FMCSA at the beginning of this year and generally supported by the AV industry.[21] If approved, the exemption would allow Cab-Mounted Warning Beacons—a lighting system composed of forward- and rearward-facing amber flashing lights—to be used by autonomous trucks when stopped on the roadway in lieu of manually placing traditional warning triangles or flares around the vehicle, as required by regulation today.[22]

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[19] See "Forefront: Securing Pittsburgh's Break-out Position in Autonomous Mobile Systems," Sept. 2021, https://ridc.org/news/autonomy-study/.

[20] See, e.g., NHTSA, Framework for Automated Driving Systems Safety, RIN 2127-AM15 and FMCSA, Safe Integration of Automated Driving Systems-Equipped Motor Vehicles, RIN 2126-AC17.

[21] https://www.federalregister.gov/documents/2023/03/03/2023-04385/parts-and-accessories-necessary-for-safe-operation-exemption-application-from-waymo-llc-and-aurora

[22] https://www.freightwaves.com/news/on-the-roadside-dont-forget-the-safety-triangles

To support the application, two separate and independent studies (naturalistic and closed course) showed that Cab-Mounted Warning Beacons were equally or more effective in enabling road users to detect, recognize, and react to the hazard presented by a truck parked on the roadway when compared to warning triangles. Aurora's naturalistic study captured the responses of approximately 7,500 road users for the proposed warning device, across a variety of lighting conditions and interstate roadway geometries. Because there is no available FMCSA data of which we are aware that evaluates the effectiveness of traditional warning devices in motor carrier operations, the naturalistic study captured drivers' responses to both types of devices to support a data based decision.

The studies found that people slowed down and/or moved over when the Cab-Mounted Warning Beacons were activated, which is exactly what is expected and is consistent with the underlying regulation's safety purpose. Specifically, the studies showed that approaching drivers were able to see and understand the hazard, usually well beyond 300 meters behind the truck, and would slow down and/or change lanes away from the parked truck. This behavior was consistent with both the conventional warning devices and the Cab-Mounted Warning Beacons.

Approval of the exemption for motor carriers operating autonomous trucks to use Cab-Mounted Warning Beacons in lieu of traditional warning devices could also benefit conventional motor carrier operations in the future, where the proposed warning device may provide added protection to human drivers and to other road users. While the pending exemption application is limited to trucks operated by an ADS, in the future, the ability to use Cab-Mounted Warning Beacons could apply to all motor carrier operations. Use of the proposed warning device would provide human drivers with an immediate warning system to alert passing motorists when stopping on a roadway and eliminate the need for the driver to get out of their truck, enter the roadway, and walk hundreds of feet to place warning triangles or flares around the truck.

There is strong support for the application. Freight and trucking partners of Aurora including Hirschbach, Werner, Uber Freight, and Volvo Autonomous Solutions have filed support statements in the Federal Register. In addition, Daimler Trucks, AVIA, Consumer Technology Association, TechNet, U.S. Chamber of Commerce, AUVSI, Kodiak, Waabi, and Gatik have filed statements of support with FMCSA for the exemption application. While more than eight months have passed since the application was filed, we remain hopeful that FMCSA will grant the application and use the five year exemption period to learn more about novel warning device solutions and the safe integration of AVs into the U.S. trucking fleet.

Impact of the Current Regulatory Framework

Aurora supports maintaining the existing self-certification process for motor vehicles in the United States, and believes companies should use Safety Case-based arguments, supported by evidence, to make safety determinations as discussed at length above.

We believe Congress should pass legislation confirming the federal government maintains its regulatory authority over the design, construction, and performance of AVs. Every vehicle that is on public roads, including an AV, is subject to the Motor Vehicle Safety Act, which provides NHTSA with broad authority over the safety of motor vehicles and motor vehicle equipment and to issue and update regulations as necessary for the purpose of reducing traffic crashes. States can, and should, continue to establish safety programs that address such intrastate operational issues as vehicle registration and insurance, driver testing and licensing, traffic rules, and highway design and maintenance. However, in the exercise of their responsibility over motor vehicle operations, states have adopted a widely varying and inconsistent patchwork of laws and regulations that may hinder the efficient and widespread adoption of AVs. There is tremendous value in leadership from the federal government supporting the AV industry through its convening authority to, as suggested in NHTSA's Preparing for the Future of Transportation: Automated Vehicles 3.0 (AV 3.0), provide technical assistance and best practices to states.

We agree with NHTSA's AV 3.0 that the federal government has the opportunity to encourage uniformity of state regulatory and operational environments. For example, states often have conflicting rules of the roads that make it difficult for all drivers, whether autonomous or human, to operate. Some jurisdictions require drivers to use a bike lane to make a right hand turn, while others prohibit doing so. We do not have a position on what is the safest option, but we do believe that uniformity across states would be beneficial for all road users, including the Aurora Driver. Congress could provide valuable guidance to states and NHTSA on tackling this patchwork of laws that affects all drivers, human and autonomous.

We will continue to encourage NHTSA and FMCSA to reach out to industry as they are developing AV-related policies and guidance. When appropriate, we will take the opportunity to comment on the record and suggest concrete improvements to those policies. For example, the difference between driver assistance systems and the autonomous system we are building is critical for the public to understand. The language and definitions the agencies use in regulations, orders, and guidance will drive the public discourse and need to be clear for all stakeholders. We will continue investing in an elevated public discourse on these topics. For example, Aurora is a founding member of PAVE, the Partnership for Automated Vehicle Education, because of how important we believe engagement and education is for all stakeholders.

Closing

Transparency and collaboration are key to our progress and future at Aurora. We are committed to continuing to work with the Subcommittee as it addresses these important issues and supports safety, innovation, and jobs across the United States. The incredible power and importance of our trucking industry here in the United States cannot be overstated. From making sure shelves around the country are stocked with essentials to the incredible increase in demand for 2-day home delivery, trucking is the backbone of the economy and, like every other industry, needs innovation to continue to thrive.

We are in the exciting and early stages of the next wave of safety innovation for the motoring public. I believe in the promise of AV technology, not for its own sake, but for the families, communities, and workplaces that will see the benefits of fewer crashes on our roads. Eliminating the loss of life on our roadway will not happen overnight, but we must move with urgency and automated vehicles will be part of the solution. The United States has been an incredible place to build and grow Aurora, and I look forward to seeing the nation benefit from this important technology. Thank you for the opportunity to provide this testimony and to answer the Subcommittee's questions.