Committee on Transportation and Infrastructure
U.S. House of Representatives
Washington DC 20515

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January 31, 2022

SUMMARY OF SUBJECT MATTER

TO: Members, Subcommittee on Highways and Transit
FROM: Staff, Subcommittee on Highways and Transit
RE: Subcommittee Hearing on "The Road Ahead for Automated Vehicles"

PURPOSE

The Subcommittee on Highways and Transit will meet on Wednesday, February 2, 2022, at 11:00 a.m. in 2167 Rayburn House Office Building and virtually via Zoom to receive testimony related to the hearing entitled "The Road Ahead for Automated Vehicles." The purpose of this hearing is for Members of the Subcommittee to explore the impact of automated vehicle deployment, including automated trucks and buses, on mobility, infrastructure, safety, workforce, and other economic and societal implications or benefits. The Subcommittee will hear from representatives of the National League of Cities, American Association of State Highway and Transportation Officials, Advocates for Highway and Auto Safety, University of Oregon, Transport Workers Union of America, Autonomous Vehicle Industry Association, Teamsters, and Aurora.

BACKGROUND

Automated vehicles (AVs), including automated trucks and buses, are vehicles in which the safety-critical control functions (e.g., steering, acceleration, or braking) can occur without direct driver input.[1] There are at least 1,400 automated vehicles, including automated trucks, currently in testing by more than 80 companies across 36 states, according to the U.S. Department of Transportation (DOT).[2]

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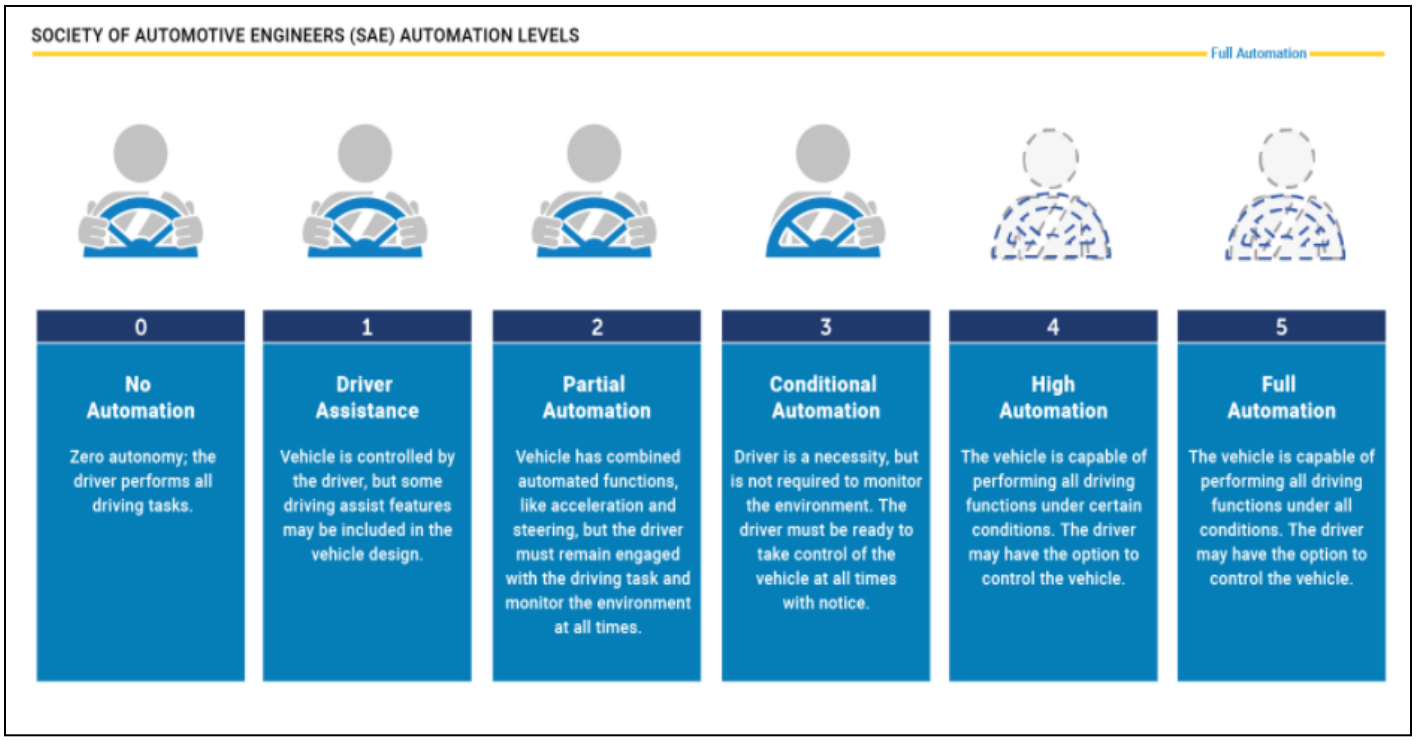
[1] National Highway Traffic Safety Administration, Automated Vehicles, https://one.nhtsa.gov/Research/Crash-Avoidance/Automated-Vehicles. Accessed January 18, 2022.
[2] Darrell Etherington, "Over 1,400 self-driving vehicles are now in testing by 80+ companies across the US," *Tech* Crunch, June 11, 2019, https://tcrn.ch/3fUunoP. Accessed January 18, 2022.

AV Technology

The Society of Automotive Engineers (SAE) classifies vehicle automation into six levels. The levels of automation are as follows:[3]

- Level 0: No Driving Automation
- Level 1: Driver Assistance
- Level 2: Partial Driving Automation
- Level 3: Conditional Driving Automation
- Level 4: High Driving Automation
- Level 5: Full Driving Automation



Source: National Highway Traffic Safety Administration (https://bit.ly/34dUqVI)

Only vehicles equipped with levels 3, 4, or 5 automation are considered automated vehicles. The combination of hardware and software that automates control functions of AVs is called the automated driving system (ADS).[4] Vehicles with levels 0-2 automation are considered equipped with automated driver assistance systems (ADAS). Many vehicles available today are equipped with some automation (levels 1-2), which includes features such as automatic emergency braking and lane centering.[5] Although vehicles equipped with level 3-5 automation are not yet commercially available,

[3] SAE International, Taxonomy and Definitions for Terms Related to Driving Automation Systems for On-Road Motor Vehicles (J3016_202104), Revised April 30, 2021, https://www.sae.org/standards/content/j3016_202104/. Accessed January 18, 2022.

[4] National Highway Traffic Safety Administration, Automated Vehicles for Safety, https://bit.ly/33L01TA. Accessed January 18, 2022.

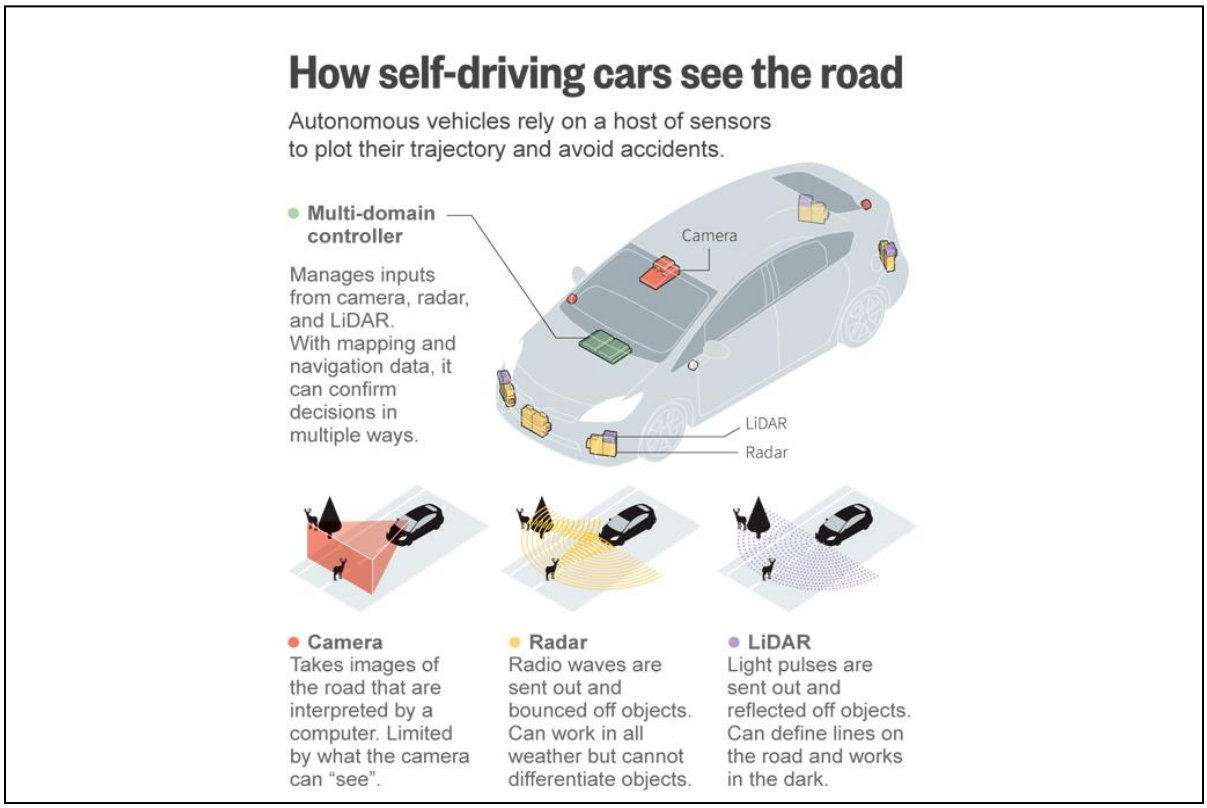
[5] SAE International, "SAE Levels of Driving Automation™ Refined for Clarity and International Audience," May 3, 2021, https://www.sae.org/blog/sae-j3016-update. Accessed January 18, 2022.

many trucking companies have partnered with self-driving technology firms and are testing trucks with level 4 service and some jurisdictions are providing level 4 autonomous transit service. [6]

The conditions and scenarios under which an AV can safely operate is called an operational design domain (ODD).[7] These conditions may include geographies, roadway types, speed range, weather, and time of day.[8] AVs with more limited ODDs, such as automated long-haul trucks operating only on Interstate highways, may be closer to deployment. Conversely, AVs with more complex ODDs, such as automated passenger vehicles operating in dense urban areas, have a more complex path to deployment.

In place of a human driver, AVs "see" the road using a complex, complementary suite of technologies that work together to paint a picture of their environment.[9] Examples of these technologies may include the following:[10]

- LiDAR: uses light to detect objects and distances.
- Radar: uses electromagnetic waves to detect objects and movement.
- Vision systems: uses cameras to capture the surrounding environment and important objects, such as traffic lights, construction zones, school buses, and the lights of emergency vehicles.
- Computers: processes images captured by cameras to discern between objects.



Source: World Economic Forum (https://bit.ly/3rWYwcP)

[6] https://bit.ly/3ofrC6m ; https://bit.ly/3IOhU2w ; https://bit.ly/3IVHAdL
[7] Waymo, "Waymo Safety Report," page 16, February 2021. https://bit.ly/33KBb6j. Accessed January 18, 2022.
[8] Ibid.
[9] Ibid, page 14.
[10] Ibid.

Similar to automated vehicles, connected vehicles (CVs) operate by transmitting radio signals that allow CVs to communicate with both other CVs and the surrounding environment.[11] CVs utilize the 5.9 gigahertz radio frequency band to enable vehicle-to-everything (V2X) communications through a technology called dedicated short-range communications (DSRC).[12] Connected vehicle technology is largely different than automated vehicle technology, but the two technologies may eventually merge and complement one another. Connected vehicles are not yet broadly commercially available, and the technology is still in development. In 1999, the Federal Communications Commission (FCC) reserved 75 MHz in the 5.9 GHz spectrum band for DSRC for use with Intelligent Transportation Systems (ITS) to develop and test technologies that increase roadway safety.[13] In November 2020, the FCC authorized unlicensed Wi-Fi devices to share more than half of the 5.9 GHz band, reducing the amount of spectrum available for V2X devices to 30 MHz.[14] This controversial action was criticized by members of the Committee on Transportation and Infrastructure,[15] State Departments of Transportation, and the Intelligent Transportation Society of America.[16] At that time, DOT stated that the FCC's decision "suffers from numerous deficiencies."[17]

Mobility

AV technology has the potential to revolutionize mobility and make the transport of goods and people easier, cheaper, more efficient, and more accessible.[18] AVs could improve mobility for vulnerable groups, including the elderly and those with disabilities.[19] Adoption of AVs may provide options to those facing transportation challenges, increasing their access to jobs and services and their ability to live independently.[20] Expanding transportation options for underrepresented

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[11] U.S. Department of Transportation, How Connected Vehicles Work, Updated February 27, 2020, https://www.transportation.gov/research-and-technology/how-connected-vehicles-work. Accessed January 23, 2022.
[12] Ibid.
[13] Federal Communications Commission, "Defining Safety of Life in 5.9 GHz, Michael O'Rielly, Commissioner June 8, 2016, available at https://www.fcc.gov/news-events/blog/2016/06/08/defining-auto-safety-life-59-ghz. Accessed January 27, 2022.
[14] Federal Communications Commission, "First Report and Order, Further Notice of Proposed Rulemaking, and Order of Proposed Modification in the Matter of the Use of the 5.850-5.925 GHz Band," ET Docket No. 19-138. November 18, 2020. https://www.fcc.gov/document/fcc-modernizes-59-ghz-band-improve-wi-fi-and-automotive-safety-0. Accessed January 23, 2022.
[15] Letter to the DOT from the Committee on Transportation and Infrastructure. 2020-01-22 Full TI Letter to FCC.pdf (house.gov). Accessed January 26, 2022.
[16] Traffic Technology Today Website, ITS America and AASHTO ask US Transportation Secretary to preserve 5.9 GHz spectrum for V2X" March 16, 2021. available at ITS America and AASHTO ask US Transportation Secretary to preserve 5.9 GHz spectrum for V2X | Traffic Technology Today. Accessed January 26, 2022.
[17] U.S. Department of Transportation, Comments in the Federal Register, "First Report and Order, Further Notice of Proposed Rulemaking, and Order of Proposed Modification in the Matter of the Use of the 5.850-5.925 GHz Band," ET Docket No. 19-138, November 6, 2020, page 1, https://bit.ly/344O0YL. Accessed January 23, 2022.
[18] JTL Urban Mobility Lab at MIT, Autonomous Vehicles and Cities, available at https://mobility.mit.edu/av.
[19] National Highway Traffic Safety, Automated Vehicles for Safety, available at https://www.nhtsa.gov/technology-innovation/automated-vehicles-safety. Accessed January 26, 2022.
[20] U.S. Department of Transportation and National Science & Technology Council, "Ensuring American Leadership in Automated Vehicle Technologies: Automated Vehicles 4.0," January 2020, page 8, available at https://www.transportation.gov/sites/dot.gov/files/docs/policy-initiatives/automated-vehicles/360956/ensuringamericanleadershipav4.pdf. Accessed January 24, 2022.

communities may address one of the major barriers to entry for enhanced equality and inclusion in society.[21] In addition, AVs may also facilitate quicker and cheaper freight transportation.[22]

Infrastructure and AVs

Because AVs will "see" the road differently, transportation officials are beginning to evaluate the role of road infrastructure in the safe deployment of AVs.

Stakeholders have noted that roadways and traffic control devices—which include signs and lane markings—will likely need to be in a state of good repair for safe AV operation.[23] For example, today's AV technology may be unable to accurately read, interpret, and take the proper action in the presence of potholes, unclear road signage, or faded lane markings.[24] Similarly, traffic control devices today are not uniform across all states and are designed for humans to interpret. [25] Different states and regions use different kinds of traffic control devices.[26] It is unclear how AVs and their technologies—which vary between companies—may develop to interpret disparate signs and lane markings in the future.[27]

The Federal Highway Administration (FHWA) is in the early stages of evaluating the role of infrastructure in the deployment of AVs and what federal action may be necessary. This includes researching what data is needed for updating infrastructure, modeling how AVs may impact traffic operations, and awarding grants to allow states and localities to pursue their own research.[28]

FHWA is also in the process of updating the national Manual on Uniform Traffic Control Devices (MUTCD) to account for AVs. The national MUTCD is a manual developed by FHWA that sets minimum standards and provides guidance for traffic control devices.[29] In December 2020,

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[21]Automotive World, Automated vehicles: the opportunity to create an inclusive mobility system, March 27, 2019, available at https://www.automotiveworld.com/articles/automated-vehicles-the-opportunity-to-create-an-inclusive-mobility-system/#:~:text=Automated%20vehicles%20are%20expected%20to%20improve%20mobility%20and,mobility%20today%2C%20existing%20mobility%20issues%20may%20be%20amplified., Accessed January 26, 2022.

[22] Driving Automation Systems in Long-Haul Trucking and Bus Transit: Preliminary Analysis of Potential Workforce Impacts (transportation.gov) page 9, available at Driving Automation Systems in Long-Haul Trucking and Bus Transit: Preliminary Analysis of Potential Workforce Impacts (transportation.gov). Accessed January 27, 2022.

[23] Connected and Autonomous Vehicles Impacts Committee of the American Society of Civil Engineers, Comments in the Federal Register, "Automated Driving Systems," Docket No. FHWA-2017-0049, March 5, page 3, https://www.regulations.gov/comment/FHWA-2017-0049-0079. Accessed January 20, 2022.

[24] American Traffic Safety Services Association, Comments in the Federal Register, "Automated Driving Systems," Docket No. FHWA-2017-0049, March 5, page 2. https://www.regulations.gov/comment/FHWA-2017-0049-0067. Accessed January 20, 2022.

[25] Ibid.

[26] Ibid.

[27] Connected and Autonomous Vehicles Impacts Committee of the American Society of Civil Engineers, Comments in the Federal Register, "Automated Driving Systems," Docket No. FHWA-2017-0049, March 5, page 4, https://www.regulations.gov/comment/FHWA-2017-0049-0079. Accessed January 20, 2022.

[28] U.S. Department of Transportation and National Science & Technology Council, "Ensuring American Leadership in Automated Vehicle Technologies: Automated Vehicles 4.0," January 2020, page 21, https://www.transportation.gov/sites/dot.gov/files/2020-02/EnsuringAmericanLeadershipAVTech4.pdf. Accessed January 21, 2022; Federal Highway Administration, "Automated Driving Systems," Docket No. FHWA-2017-0049, January 18, 2018, https://www.regulations.gov/document/FHWA-2017-0049-0001. Accessed January 21, 2022.

[29] Federal Highway Administration, Manual on Uniform Traffic Control Devices, "Overview," https://mutcd.fhwa.dot.gov/kno-overview.htm. Accessed January 21, 2022.

FHWA published a Notice of Proposed Rulemaking (NPRM) to amend the MUTCD with, among other modifications, new guidance focused on accommodating AVs.[30] This rulemaking is currently underway, and the comment period closed on May 14, 2021.[31]

Safety and Federal Actions

Automated vehicles have the potential to drastically increase vehicle safety and reduce motor vehicle crashes and deaths. In 2020, there were 38,680 people killed in motor vehicle crashes on U.S. roadways.[32] Despite an initial drop in the number of vehicle miles traveled, traffic fatalities have increased dramatically since the start of the COVID-19 pandemic. Early estimates show that 20,160 people died in the first half (January-June) of 2021, an increase of 18.4 percent over the same time period in 2020.[33] This represents the largest number of projected fatalities in the first half of the year since 2006 and the highest half-year percentage increase in the history of data recorded, according to the National Highway Traffic Safety Administration (NHTSA).[34]

DOT's research has indicated that up to 94 percent of serious crashes involve human factors.[35] However, the Chair of the National Transportation Safety Board (NTSB) has recently criticized that statistic as "misleading."[36] AVs can mitigate or correct driver error, and level 5 AVs have the potential to remove the need for a human driver from the chain of events that can lead to a crash. Provided that AVs respond appropriately to avoid a crash, this heralds the potential to significantly increase safety for drivers, passengers, and other road users; and reduce the economic costs of crashes.[37] Trucking and technology firms are currently testing the technology to ensure that AVs can and will respond appropriately in complex traffic and varying roadway conditions.

Because automated vehicles are still in development, AV regulatory regimes are still in their beginning stages.[38] At the federal level, automated vehicle safety is overseen by NHTSA. Although there is no overarching federal framework for automated vehicles, DOT has taken preliminary steps to adapt its regulatory regime for AVs. Since 2016, DOT has released several iterations of voluntary guidance for AVs, the latest being the "Automated Vehicles Comprehensive Plan" and "Ensuring American Leadership in Automated Vehicle Technologies: Automated Vehicles 4.0."[39] In December

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[30] Federal Highway Administration, "National Standards for Traffic Control Devices: Manual on Uniform Traffic Control Devices for Streets and Highways; Revision," Docket No. FHWA-2020-0001, December 14, 2020, https://www.regulations.gov/document/FHWA-2020-0001-0001. Accessed January 21, 2022.
[31] Federal Highway Administration, "National Standards for Traffic Control Devices; the Manual on Uniform Traffic Control Devices for Streets and Highways; Revision," Docket No. FHWA-2020-0001, February 2, 2021, https://www.federalregister.gov/documents/2021/02/02/2021-01440/national-standards-for-traffic-control-devices-the-manual-on-uniform-traffic-control-devices-for. Accessed January 27, 2022.
[32] https://crashstats.nhtsa.dot.gov/Api/Public/ViewPublication/813199. Accessed January 30, 2022.
[33] Ibid.
[34] Ibid.
[35] https://crashstats.nhtsa.dot.gov/Api/Public/ViewPublication/812456. Accessed January 30, 2022.
[36] https://www.ttnews.com/articles/ntsbs-homendy-calls-dots-serious-crash-stat-misleading.
[37] National Highway Traffic Safety Administration, Automated Vehicles for Safety, available at National Highway Traffic Safety Administration, Automated Vehicles for Safety | NHTSA. Accessed on January 26, 2022.
[38] U.S. Department of Transportation and National Science & Technology Council, "Ensuring American Leadership in Automated Vehicle Technologies: Automated Vehicles 4.0," January 2020, page 7, https://www.transportation.gov/sites/dot.gov/files/2020-02/EnsuringAmericanLeadershipAVTech4.pdf. Accessed January 23, 2022.
[39] Ibid.

2020, NHTSA published an Advance Notice of Proposed Rulemaking (ANPRM) seeking public comment on the potential development of a framework of principles to govern AV safety.[40]

Because private companies are in the early stages of developing, testing, and piloting AVs and AV technologies, there is little publicly available data on collision rates and vehicle safety.[41] NHTSA encourages automated vehicle manufacturers to submit Voluntary Safety Self-Assessments (VSSAs) demonstrating their approaches to safe testing and deployment of AVs.[42] To date, 29 companies have submitted VSSAs to NHTSA.[43] NHTSA also encourages AV companies to voluntarily disclose information, including location and type of vehicle, through the Automated Vehicle Transparency and Engagement for Safe Testing (AV TEST) tracking tool.[44] All of this information is publicly available. In June 2021, NHTSA issued a Standing General Order that requires AV manufacturers and operators to report crashes to the agency.[45]

The Federal Motor Carrier Safety Administration (FMCSA) establishes Federal Motor Carrier Safety Regulations (FMCSRs), which set minimum safety standards for motor carriers and drivers.[46] In May 2019, FMCSA released an ANPRM requesting comment on FMCSRs that may need to be updated, modified, or eliminated to facilitate the safe introduction of automated commercial motor vehicles.[47] Potentially affected FMCSRs included Licensing and Driver Qualifications, Hours of Service, and Safe Driving.[48] The NPRM is currently under internal agency review.[49]

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[40] National Highway Traffic Safety Administration, "Framework for Automated Driving System Safety," Docket No. NHTSA-2020-0106, December 3, 2020, https://www.regulations.gov/document/NHTSA-2020-0106-0001. Accessed January 23, 2022.

[41] U.S. Department of Transportation and National Science & Technology Council, "Ensuring American Leadership in Automated Vehicle Technologies: Automated Vehicles 4.0," January 2020, page 7, https://www.transportation.gov/sites/dot.gov/files/2020-02/EnsuringAmericanLeadershipAVTech4.pdf. Accessed January 23, 2022.

[42] National Highway Traffic Safety Administration, "Automated Driving Systems 2.0: A Vision for Safety," September 2017, page 7, https://www.nhtsa.gov/sites/nhtsa.gov/files/documents/13069a-ads2.0_090617_v9a_tag.pdf. Accessed January 23, 2022.

[43] National Highway Traffic Safety Administration, Voluntary Safety Self-Assessment, https://www.nhtsa.gov/automated-driving-systems/voluntary-safety-self-assessment. Accessed January 23, 2022.

[44] National Highway Traffic Safety Administration, AV TEST Initiative, https://www.nhtsa.gov/automated-vehicle-test-tracking-tool. Accessed January 23, 2022.

[45] National Highway Traffic Safety Administration, Standing General Order on Crash Reporting for Levels of Driving Automation 2-5, https://www.nhtsa.gov/laws-regulations/standing-general-order-crash-reporting-levels-driving-automation-2-5. Accessed January 23, 2022.

[46] Federal Motor Carrier Safety Administration, "What Are Federal Motor Carrier Safety Regulations (FMCSRs) and Hazardous Materials Regulations (HMRs) and Where are They Published?", The Motor Carrier Safety Planner, https://bit.ly/3nWFJwY.

[47] Federal Motor Carrier Safety Administration, "Automated Driving Systems (ADS) for Commercial Motor Vehicles (CMVs); Request for Comments Concerning Federal Motor Carrier Safety Regulations (FMCSRs) Which May Be a Barrier to the Safe Testing and Deployment of ADS-Equipped CMVs on Public Roads," Docket No. FMCSA-2018-0037, March 26, 2018, https://www.regulations.gov/docket/FMCSA-2018-0037. Accessed January 23, 2022.

[48] Federal Motor Carrier Safety Administration, "Automated Driving Systems (ADS) Policy Development for Commercial Vehicle Operations," March 10, 2021, page 5, https://bit.ly/3AAkMNx. Accessed January 23, 2022.

[49] Ibid, page 6.

State and Local Actions

In lieu of a federal AV framework, 41 states and the District of Columbia have enacted legislation or issued executive orders related to AVs.[50] Most of these state actions are intended to encourage AV development and testing.[51] Some of these actions incorporate AVs into the state's broader regulatory framework, including operating authorities, safety standards, licensing and registration requirements, and liability laws.[52]

Workforce Impacts

While it is difficult to determine the exact impact AVs will have on the nation's workforce, automating the task of driving commercial motor vehicles could dramatically change professional driving careers in numerous ways. Impacts could include job displacement, changes in job responsibilities, and changes in wages and quality of life.[53] According to DOT analysis, the primary economic motivation for adoption of advanced AV technology (e.g., level 5) is to remove the need for a human driver and thereby reduce operating costs.[54]

According to DOT estimates, the current size of the heavy truck and tractor-trailer driver workforce is approximately 2 million drivers, making it one of the largest occupational sectors in the U.S.[55] The American Trucking Associations estimates that the industry needs 80,000 more drivers today with those estimates expected to surpass 160,000 drivers by 2030.[56] Other segments of the industry cite driver retention as the workforce challenge most plaguing the industry, highlighting driver wages and working conditions as obstacles to attracting and retaining qualified drivers.[57] These groups point to U.S. Department of Labor analysis of trucking industry turnover rates,[58] as well as FMCSA estimates that over 400,000 commercial driver's licenses are issued each year.[59] Some segments of the trucking industry view driving automation and the possible quality of life

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[50] National Conference of State Legislatures, Autonomous Vehicles State Bill Tracking Database, Updated January 12, 2022, https://www.ncsl.org/research/transportation/autonomous-vehicles-legislative-database.aspx. Accessed January 23, 2022.
[51] Ibid.
[52] Ibid.
[53] U.S. Department of Transportation, "Driving Automation Systems in Long-Haul Trucking and Bus Transit: Preliminary Analysis of Potential Workforce Impacts," January 2021, page 9, https://bit.ly/3AKXPHP. Accessed January 24, 2022.
[54] Ibid, page 42.
[55] U.S. Department of Transportation, "Driving Automation Systems in Long-Haul Trucking and Bus Transit: Preliminary Analysis of Potential Workforce Impacts," January 2021, page 38, https://bit.ly/3AKXPHP. Accessed January 24, 2022.
[56] Transport Topics, "Truck Driver Shortage Looms over 2022, December 22, 2021, available at https://www.ttnews.com/articles/truck-driver-shortage-looms-over-2022. Accessed January 26, 2022.
[57] Todd Spencer, Owner-Operator Independent Drivers Association, Testimony to House Committee on Transportation and Infrastructure, June 12, 2019, https://docs.house.gov/meetings/PW/PW12/20190612/109600/HHRG-116-PW12-Wstate-SpencerT-20190612.pdf. Accessed January 26, 2022.
[58] U.S. Department of Labor, "Is the U.S. labor market for truck drivers broken?", March 2019, https://www.bls.gov/opub/mlr/2019/article/is-the-us-labor-market-for-truck-drivers-broken.htm. Accessed January 26, 2022.
[59] FreightWaves, "OOIDA urges Biden administration to bust driver shortage 'myth'," August 2021, https://www.freightwaves.com/news/ooida-urges-biden-administration-to-bust-driver-shortage-myth. Accessed January 26, 2022.

improvement as having the potential to help address the estimated demand for new truck drivers in the long-haul trucking segment.[60]

The adoption of automation technologies has historically been associated with some level of job displacement. Potential trucking workforce job displacement is unknown at this point and may vary based on several factors. DOT analysis notes that displacement would be limited for business models in which a driver remains in the vehicle, regardless of their onboard duties.[61] Increased adoption of low-level automation (e.g., levels 1, 2, and 3) is unlikely to bring about driver job displacement but may lead to improvements in safety and operations and quality of life.[62] In the long term, the adoption of Level 4 or 5 AVs may supplant certain driving tasks and reduce the need for human drivers, displacing workers and creating periods of transitional unemployment for some affected workers.[63] Within the trucking sector, job displacement may be experienced first in the long-haul sector due to the long periods of uninterrupted highway driving (a less complex driving task to automate).[64] Researchers have attempted to estimate the impact of AVs on trucking job displacement. Some studies show that job displacement estimates may vary from a low-end of 19 to 25 percent up to 60 to 65 percent of all heavy truck and tractor-trailer driver jobs; however, these estimates should be reexamined as they may be limited by the need for new and additional data.[65] Other studies contradict the finding that automation will result in job losses.[66] Additionally, certain portions of long haul trucking may be more vulnerable to displacement because of a less complex operating environment on highways.[67]

However, the more advanced driving automation systems may spur increased demand for complementary occupations and create new jobs separate from manual truck driving. For example, additional, highly skilled mechanics would be required to maintain and repair the increasingly complex technologies.[68] In addition, experienced drivers could be employed at trucking control centers that remotely pilot trucks.[69]

According to the National Transit Database, there were approximately 102,000 transit bus drivers in the U.S. in 2020.[70] However, transit agencies across the nation are reporting bus driver shortages, which threaten the ability of transit agencies to resume pre-pandemic operations.[71]

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[60] Driving Automation Systems in Long-Haul Trucking and Bus Transit: Preliminary Analysis of Potential Workforce Impacts (transportation.gov) page 39; Three Major Benefits of Autonomous Trucking : Redwood Logistics. Accessed January 26, 2022.
[61] Ibid, page 42.
[62] Ibid, page 38 and 45.
[63] Ibid.
[64] Ibid, page 63.
[65] Ibid.
[66] Harvard Business Review, Automation Isn't About to Make Truckers Obsolete, Maurey Gittleman and Kristen Monaco, September 18, 2019, available at https://hbr.org/2019/09/automation-isnt-about-to-make-truckers-obsolete. Accessed January 29, 2022.
[67] Driving Automation Systems in Long-Haul Trucking and Bus Transit: Preliminary Analysis of Potential Workforce Impacts (transportation.gov) page 63; And Three Major Benefits of Autonomous Trucking : Redwood Logistics. Accessed January 26, 2022.
[68] Ibid, page 41.
[69] Ibid, page 44.
[70] This information was provided to the Committee by the Federal Transit Administration via email on January 27, 2022.
[71] National Public Radio, "A shortage of bus drivers is causing problems for those who use public transportation" January 17, 2022. *available at* https://www.npr.org/2022/01/17/1073661319/a-shortage-of-bus-drivers-is-causing-

Agencies have had to cut transit service to cope, resulting in hardships for those that depend on bus transit to get to work, school, or shopping to access other services[72] Fully automating transit operator jobs is likely to be difficult due to the complexity of the environments in which transit buses operate. At high levels of automation, transit agencies may elect to replace bus driver positions with service-oriented roles such as "non-driving onboard attendants" who would be responsible for tasks that are difficult to automate, such as collecting fares and securing wheelchairs.[73] However, these positions may be lower-skilled and may receive lower pay and benefits since the driving component and Commercial Driver's License credential requirement would be eliminated. Alternatively, AVs may create new job opportunities for transit workers in the logistics arena, such as control center staff to provide remote supervision and dispatch services.[74]

Economics and Societal Implications and Benefits

Beyond increased mobility and safety, the broad adoption of AVs may bring numerous potential benefits to the American public. For example, the increase in safety could provide society with significant benefits in avoiding the deaths, injuries, and other human costs associated with truck and bus crashes.[75] While many crash impacts are intangible, trucking firms and transit agencies could also realize direct cost savings from reduced repair and maintenance costs, insurance premiums, and vehicle downtime.[76]

Reducing crashes and their resulting delays will increase the efficiency of bus and truck operations and increase the capacity and throughput on our roads.[77] Traffic optimization, a potential benefit of AVs if they respond appropriately to traffic conditions, is likely to reduce commuting times.[78] In addition, AVs have the potential to improve fleet utilization. For example, without a

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problems-for-those-who-use-public-transport; https://www.wkbw.com/news/local-news/transit-union-president-says-nfta-bus-driver-shortage-is-wage-not-pandemic-related#:~:text=Transit%20Union%20president%20says%20NFTA%20bus%20driver%20shortage,benefits%2C%20as%20well%20as%20pension%20and%20post-retirement%20benefits; https://www.mercurynews.com/2021/12/29/bay-area-transit-looks-to-woo-new-bus-operators-amid-national-driver-shortage/ ; https://minnesota.cbslocal.com/2021/09/20/metro-transit-route-cancellations/; https://www.koin.com/local/multnomah-county/trimet-to-limit-bus-service-amid-agencys-worst-ever-driver-shortage/; https://www.wusa9.com/article/news/local/dc/metry-bus-driver-shortage-route-delays/65-3b47fefb-a065-4a5a-9471-6d45864c388b; https://www.thecity.nyc/2021/5/24/22452250/mta-bus-driver-shortage-canceled-trips-and-waits.; ; https://minnesota.cbslocal.com/2021/09/20/metro-transit-route-cancellations/; Accessed January 25, 2022

[72] Ibid.

[73] Driving Automation Systems in Long-Haul Trucking and Bus Transit: Preliminary Analysis of Potential Workforce Impacts (transportation.gov) page 58, available at Driving Automation Systems in Long-Haul Trucking and Bus Transit: Preliminary Analysis of Potential Workforce Impacts (transportation.gov). Accessed January 29, 2022.

[74] Ibid, page 59.

[75] U.S. Department of Transportation, "Driving Automation Systems in Long-Haul Trucking and Bus Transit: Preliminary Analysis of Potential Workforce Impacts," January 2021, page 40, https://www.transportation.gov/sites/dot.gov/files/2021-01/Driving%20Automation%20Systems%20in%20Long%20Haul%20Trucking%20and%20Bus%20Transit%20Preliminary%20Analysis%20of%20Potential%20Workforce%20Impacts.pdf. Accessed January 26, 2022.

[76] Ibid.

[77] IEEE.org, Decision-Making Strategy on Highway for Autonomous Vehicles Using Deep Reinforcement Learning, Liao, Liu, Tang, September 2020, available at https://ieeexplore.ieee.org/document/9190040. Accessed January 29, 2022.

[78]Science Direct, Will autonomous vehicles change auto commuters' value of travel time?, Zhong, Li, Burris, available at https://www.sciencedirect.com/science/article/abs/pii/S1361920919311010#:~:text=Autonomous%20vehicles%20co

human driver, trucks could potentially run more continuously, without the need for human drivers to rest.[79] Likewise, longitudinal control systems on buses can increase throughput in congested conditions.[80] Precision docking can improve the customer experience, particularly for passengers with disabilities, while also reducing waiting times.[81] AVs could also improve vehicle utilization, as a potential bidirectional design can eliminate end-of-run turnaround loops, and there would be no need for operator breaks.[82]

Fuel costs are the second highest cost category for the trucking industry.[83] AVs may reduce the amount of fuel required, thereby significantly reducing fuel costs and benefitting the environment.[84] Truck platooning, which uses automation to allow trucks to follow each other at a set distance between trucks, allows trucks to travel closer together and offers potential improvements in overall fuel economy.[85] A study shows that platooning with automated trucks can reduce fuel consumption by 10 to 25 percent and reduce emissions.[86]

Potential increases in productivity resulting from AVs may result in faster delivery and quicker commuting time.[87] Productivity increases together with operational savings may result in lower trucking freight rates that may be passed on to the consumer[88].

Beyond the potential direct benefits of AVs, researchers are beginning to investigate the broader societal implications of AVs. These include the effect of AVs on greenhouse gas emissions, congestion, urban design, and equity.[89] Some research suggests that AVs may not uniformly alleviate congestion.[90] Additionally, some studies suggest that AVs may increase greenhouse gas emissions

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uld%20reduce%20commuters%E2%80%99%20value%20of%20travel,communters%2C%20followed%20by%20their%20urban%20and%20rural%20counterparts. Accessed January 29, 2022.

[79] Driving Automation Systems in Long-Haul Trucking and Bus Transit: Preliminary Analysis of Potential Workforce Impacts (transportation.gov) page 44, available at Driving Automation Systems in Long-Haul Trucking and Bus Transit: Preliminary Analysis of Potential Workforce Impacts (transportation.gov). Accessed January 29, 2022.

[80] Ibid, page 54.

[81] Ibid.

[82] Ibid.

[83] Ibid, page 39.

[84] Ibid, page 38 and 39.

[85] Ibid. page 13 and 86.

[86] Global Trade, "Vehicle Automation and Carbon Emissions," Peter Buxbaum, December 22, 2016. Accessed January 28, 2022.

[87] Benefits of Going Driverless with an Autonomous Vehicle | C&D Logistics (cdlogistics.ca). Accessed January 28, 2022.

[88]National Highway Traffic Safety Administration, page 64, https://www.nhtsa.gov/press-releases/us-department-transportation-releases-preparing-future-transportation-automated; http://smarttransport.solutions/2018/05/29/freight-transpotation/#:~:text=Automated%20trucks%20have%20the%20potential%20to%20improve%20efficiency,consumption%2C%20and%20thus%20drives%20truck%20freight%20volume%20up. Accessed January 28, 2022.

[89] University of Oregon Urbanism Next, Autonomous Vehicles, https://www.urbanismnext.org/technologies/autonomous-vehicles. Accessed January 24, 2022.

[90] Liam Cummins, et al., "Simulating the effectiveness of wave dissipation by FollowerStopper Autonomous Vehicles," ResearchGate, February 2021, page 23. Available at https://www.researchgate.net/publication/349100553_Simulating_the_effectiveness_of_wave_dissipation_by_FollowerStopper_autonomous_vehicles/link/616e36e2039ba26844664ee2/download. Accessed January 29, 2022.

because of they provide easier access to travel and mobility.[91] Further research is needed to conclusively identify the effects of AVs on congestion and greenhouse gas emissions.

[91] Moneim Massar, et al., "Impacts of Autonomous Vehicles on Greenhouse Gas Emissions – Positive or Negative?", National Library of Medicine, May 23, 2021. Available at https://pubmed.ncbi.nlm.nih.gov/34071052/. Accessed January 29, 2022.

WITNESS LIST

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On behalf of the National League of Cities

Mr. Scott Marler
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On behalf of the American Association of State Highway and Transportation Officials

Mr. John Samuelsen
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