Contents

Disclaimer

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Executive Summary

Background
Since the initial focus group, the development of autonomous vehicle technology, including Automated Driving Systems (ADS) for Commercial Motor Vehicles (CMV), has continued to proceed aggressively. Now, in the third decade of the 21st Century, the question has become: How prepared is law and regulation, as applied by the judiciary, for the cases and controversies that will inevitably follow the widespread deployment of ADS in CMVs?

In recognition of the slow pace of changes in laws and regulations that are required to fairly adjudicate cases involving commercial motor vehicles (CMVs) equipped with automated driving systems (ADS), The National Judicial College (NJC) conducted a second Autonomous Vehicle Focus Group on June 28-29, 2023. The group included stakeholders from various industries such as the American Association of Motor Vehicle Administrators (AAMVA), the Commercial Vehicle Safety Alliance (CVSA), state driver licensing agencies, the judiciary, the Automated Vehicle Industry Association, the trucking industry, the insurance industry, prosecutors, the National Center for State Courts (NCSC), the National Association of Criminal Defense Attorneys, and academia. The focus of the group was to discuss their concerns, the steps they are taking within their specific areas to integrate AV and ADS-equipped CMV, and to identify statutory and regulatory gaps that need to be addressed.

Focus Group Goals
The short-term goal of the Autonomous Vehicle (AV) Focus Group was to identify the statutory and regulatory issues that need to be resolved to enable the fair and objective adjudication of cases involving AV. The long-term goal is to use the results of the Focus Group and work with stakeholders to develop a guidance document on a recommended statutory framework needed to ensure the fair and objective adjudication of cases involving AV. The guidance document in turn will be provided to legislatures to consider when enacting legislation of the regulation of AV as well as *Autonomous Trucking Regulations*.

Focus Group Design
The NJC assembled a team consisting of NJC staff and subject matter expert consultants to plan the Focus Group. The team's work included identifying key stakeholder organizations to participate, drafting background and reference materials, identifying and recruiting presenters, and developing the agenda (See Appendix 1). The planning team determined that the Focus Group would benefit from general presentations on AV and ADS technologies to provide participants with an understanding, the current state of state-by-state AV regulation, work being done by AAMVA and CVSA on the licensing and regulation of AVs, industry concerns and issues (trucking and insurance industries), and defense attorney concerns. In view of this, the agenda was developed to include stand-alone presentations on AV and ADS technologies and the state of AV regulation at the national and state levels followed by two panel

presentations, the first including public sector organizations and the second including private sector representatives.

The planning team then identified four topics for in-depth analysis through facilitated break-out sessions. The intent was to leverage the expertise of participants to identify the key issues that will need to be addressed through statute or regulation to provide judges with the legal framework to support the adjudication of cases. The Federal Motor Carrier Safety Administration (FMCSA) is currently involved in a rulemaking on AV and ADS-equipped CMV, and a key objective of the Focus Group was to consolidate and prioritize these issues to better inform the rulemaking and provide a guidance document for state legislators to consider when considering legislation on the regulation of AVs.

Stakeholder Priorities

Stakeholders overwhelmingly identified four consensus priorities: the need for Federal (FMCSA) guidance; definitional issues (updating the definition of driver); establishing a framework for and the need for assigning liability; and judicial and stakeholder outreach and education on AV and ADS.

- With respect to FMCSA guidance, stakeholders expressed concern that as states adopt a "patchwork quilt" of statutory frameworks for AV and ADS, the challenge will be to avoid 51 regulatory environments that may impede development and deployment.
- Participants collectively agreed that establishing a definition of driver is critical for moving forward with developing the AV and ADS regulatory framework. Defining the entity who is responsible for dynamic driving tasks (the AV or ADS systems, the safety driver) will help define the liable party in the event of an incident or crash and support risk identification and mitigation.
- Participants also indicated that the issue of determining liability in the event of an incident or crash presented a significant challenge. Stakeholders recognized that to a certain degree, liability issues would be addressed through case law. Stakeholders stated that establishing a framework for assigning liability would provide guidance and direction for the Judiciary.
- Participants expressed consensus on the need for judicial and stakeholder outreach and education. This included educating the judiciary and stakeholders on AV and ADS technologies and continuing to identify issues, document issue resolution, and identify best practices.

Participants noted that data privacy represents an inter-disciplinary concern that will need to be addressed. Issues discussed included cybersecurity (protecting AV and ADS systems from being hacked, ensuring the security of wireless data exchange at roadside.) and protecting Fourth Amendment rights in the digital age.

Law enforcement emphasized the need for the development of AV and ADS performance standards. These standards are needed to support roadside inspection and safety actions and determine if an AV or ADS-equipped CMV is operating safely or is experiencing a system failure that represents an imminent hazard.

Background

In 2021, the NJC with the support of the FMCSA held a two-day Autonomous Vehicle Steering Committee meeting. The focus of the meeting was on *"Collision Avoidance: How Automated Vehicles Will Interact with the Law and the Judiciary."* Participants were given an overview of automated vehicle technologies and asked to identify challenges in helping judges become familiar with this technology and the existing laws around it. They also discussed the concrete questions that autonomous systems, particularly on commercial motor vehicles like semi-trucks, will bring to courtrooms. The findings of the focus group were published as a white paper titled "Collision Avoidance: A Primer Concerning How Automated Vehicles Will Interact with the Law and the Judiciary," which was prepared by Mr. Ian Adams, Executive Director of the International Center for Law and Economics. The paper highlights the challenges posed by autonomous vehicles for the nation's courts, including their complexity, large universe of stakeholders, and the unsettled area of law in which they operate.
Since the initial focus group, the development of autonomous vehicle technology, including automated driving systems (ADS) for commercial motor vehicles (CMV), has continued to proceed aggressively. Now, in the third decade of the 21st Century, the question has become: How prepared is law and regulation, as applied by the judiciary, for the cases and controversies that will inevitably follow the widespread deployment of ADS in CMVs?

The NJC, recognizing that the necessary changes in law and regulation needed to fairly and objectively adjudicate cases continue to lag the development and deployment of CMVs equipped with ADS, conducted a second Autonomous Vehicle Focus Group on June 28-29, 2023. The Focus Group included stakeholders representing the American Association of Motor Vehicle Administrators (AAMVA, the Commercial Vehicle Safety Alliance (CVSA), state driver licensing agencies, the judiciary, the Automated Vehicle Industry Association, the trucking industry, the insurance industry, prosecutors, the National Center for State Courts (NCSC), the National Association of Criminal Defense Attorneys, and academia to discuss their respective issues and concerns, steps they are taking within their specific areas to integrate AV and ADS-equipped CMV, and statutory and regulatory gaps that need to be addressed.

Autonomous Vehicle Focus Group Goals

The Autonomous Vehicle (AV) Focus Group had a short-term goal of identifying the statutory and regulatory issues that need to be resolved to enable the fair and objective adjudication of cases involving AV. Their long-term objective is to collaborate with stakeholders to create a guidance document outlining a recommended statutory framework. This framework will guarantee the fair and objective adjudication of cases involving AV. The guidance document in turn will be provided to legislators to consider when enacting legislation of the regulation of AV.

Focus Group Design

The NJC formed a team consisting of NJC staff and subject matter expert consultants to plan the Focus Group. Their duties included identifying key stakeholder organizations to participate, drafting background and reference materials, identifying and recruiting presenters, and developing the agenda. Appendix 1 provides more information about this process. The planning team determined that the Focus Group would benefit from general presentations on AV and ADS technologies to provide participants with an understanding, the current state of state-by-state AV regulation, work being done by AAMVA and CVSA on the licensing and regulation of AVs, industry concerns and issues (trucking and insurance industries), and defense attorney concerns. Consequently, the agenda was developed to include stand-alone presentations on AV and ADS technologies and the state of AV regulation at the national and state

levels. This was followed by two panel presentations: the first including public sector organizations and the second including private sector representatives.

The planning team organized facilitated break-out sessions to delve deeper into four specific topics. The goal was to utilize the knowledge and expertise of the participants to identify the main issues that need to be addressed through the law or regulations to provide a legal framework for judges to support the adjudication of cases. Currently, FMCSA is involved in a rule-making process on AV and ADS-equipped CMV, and the objective of the Focus Group was to prioritize these issues to better inform the rule-making process and provide a guidance document for state legislators to consider when drafting legislation on the regulation of AV.

Participants were pre-assigned to the breakout session groups, and facilitators rotated between each group to ensure participation across all four breakout sessions. The breakout session groups included representatives from each of the participating stakeholders to facilitate a balanced discussion of the topic. The figure below illustrates how the breakout sessions were conducted. The planning team then identified four topics to be analyzed in more detail through facilitated break-out sessions. The intent was to leverage the expertise of participants to identify the key issues that will need to be addressed through statute or regulation to provide judges with the legal framework to support the adjudication of cases. FMCSA is currently involved in a rulemaking on AV and ADS-equipped CMV, and a key objective of the Focus Group was to consolidate and prioritize these issues to better inform the rulemaking and provide a guidance document for state legislators to consider when considering legislation on the regulation of AV.

Figure 1: Breakout Session Schedule

Group	Room	June 28 2:30 to 3:30 pm	June 28 3:40 to 4:40 pm	June 29 8:10 to 9:10 am	June 29 9:20 to 10:20 am
Group A	**Classroom 1245**	Track 1	Track 2	Track 3	Track 4
Group B	**Classroom 103**	Track 2	Track 1	Track 4	Track 3
Group C	**Room 2020 Jury Room**	Track 3	Track 4	Track 1	Track 2
Group D	**Room 2028 Judges Chambers**	Track 4	Track 3	Track 2	Track 1

Track 1: Technology and the Law
Track 2: Stakeholder Engagement and Education
Track 3: Safety and Enforcement
Track 4: Issues of Liability

On completion of the breakout sessions, the facilitators consolidated findings for their respective topics for all four sessions and reported these to all Focus Group participants. The final Focus Group activity was to prioritize the consolidated findings to use in developing a plan for moving forward to address the identified issues.

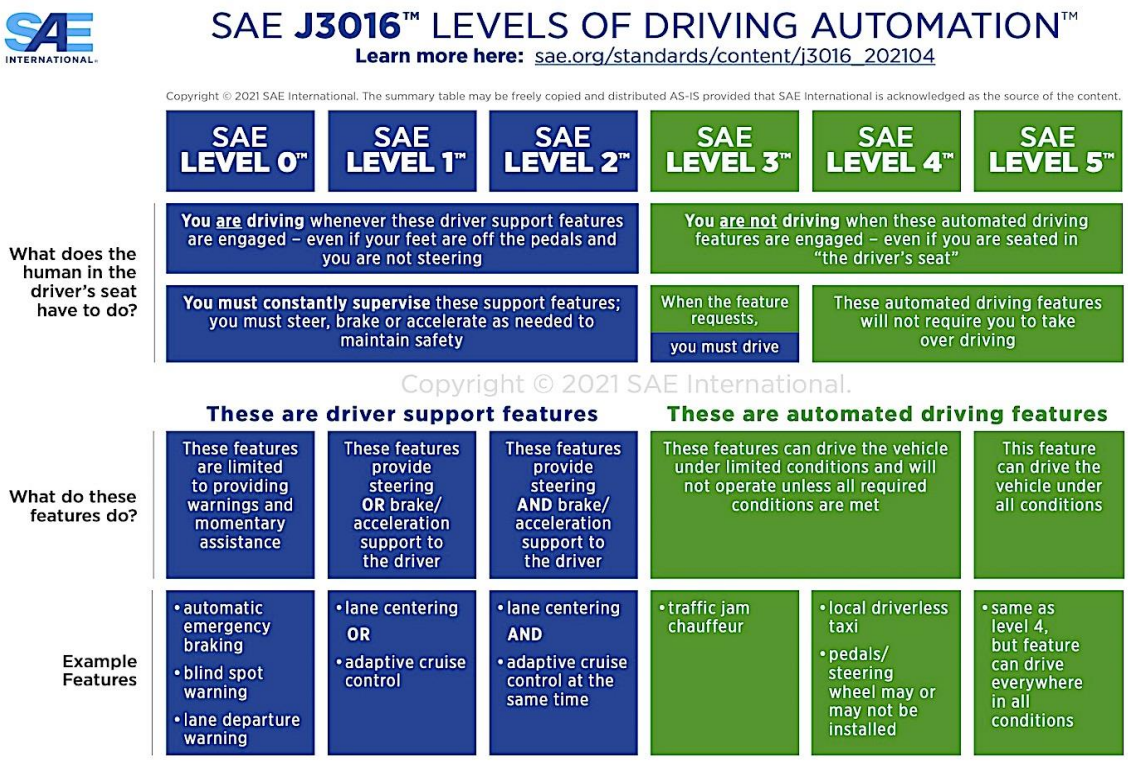
The remaining sections of the Focus Group paper present an overview of the stand-alone and panel presentations, the consolidated findings for each of the four breakout session topics, and the prioritized list of findings.

Summary of Stand Alone and Panel Presentations

Overview of Autonomous Vehicles Technology – Dr. Jiaqi Ma

Dr. Ma opened his presentation with an explanation of the Society of Automotive Engineers (SAE) J3016 Standard on the levels of automation (see Figure 1). He also provided a brief overview of the evolution of autonomous vehicles and the industry's current state.

Figure 2: Levels of Driving Automation



He then moved into the primary focus of his presentation explaining the technology supporting the development of autonomous trucks. He described the components of the autonomous driving software stack system architecture and how the software supports vehicle sensing, computing (perception, decision making, and planning) and actuation (driving events). The presentation also described how the software is designed to support AV operations, the supporting hardware (sensors) installed on AV, and the algorithms that support vehicle decision making and control for safe operations:

- The types of sensors used to support AV operations include LiDAR, Camera, Radar, GPS and Ultrasonic sensors.
- How objects are detected, tracked and classified (e.g., car, trucks, pedestrian, bicycle).
- The range of sensor suites on an AV and their functions, for example, traffic sign perception, lane departure warning, and emergency braking.
- The fusion of data from multiple sensors and how the data is used to support the decision-making algorithms that support AV.
- How the software supports planning and decision making, for example:
    - route planning (utilizing maps and GPS data to select routes)
    - behavior planning (responding to dynamic traffic conditions)
    - trajectory planning (vehicle operations, collision avoidance)
    - decision making algorithms and optimization)

- Control algorithms that support vehicle lateral and longitudinal control (steering, acceleration, braking) and vehicle dynamics (modeling vehicles responses and understanding motion and forces).

He went on to discuss the Autonomous Commercial Motor Vehicle (CMV) Evaluation Program (ACE) sponsored by the FMCSA. The program aims to prototype and test communication methods, inspection technologies, and processes to facilitate the electronic safety inspections of CMVs equipped with Automated Driving Systems (ADS). The testing will be conducted at the roadside, borders, and other fixed enforcement locations. Six operational test scenarios have been developed and prototypes are being tested to ensure the program's success.

- #1 ADS Health & Status Electronic confirmation and communication of ADS health and status on equipped CMVs

- #2 Predictive algorithms, analytics, and preventive maintenance data: Evaluate and test predictive algorithms, analytics, and preventive maintenance data (e.g., fleet management systems, total asset visibility systems) that would provide value to a roadside inspector for inclusion into their inspection application and electronic screening decision tools.

- #3 Enhanced pre-trip inspection communication: Communication of an enhanced pre-trip inspection status, certification, & data elements

- #4 Inspection/weigh station “Pull-in or Bypass”: React and comply with law enforcement electronic messaging or static signs to “Pull-in or Bypass” an inspection/weigh station.

- #5 Populate roadside inspection application Populate available data elements into a roadside inspection application when prompted or automatically.

- #6 Emergency lights/siren pull over or move over: Reaction to emergency lights and siren (SAE J3216 NO COOPERATIVE AUTOMATION) to either pull over or move over in compliance with State “Move Over Law”.

ACE demonstration was conducted using a Class 8 CMV operated by FMCSA’s CARMA decision making and control platform and tests were conducted at the Virginia Tech Transportation Institute’s (VTTI) test track in Blacksburg, Virginia. Dr. Ma was the lead developer for ACE ADS and roadside software, and he presented videos of the operational six tests conducted at VTTI that demonstrated the success of the proof of concept.

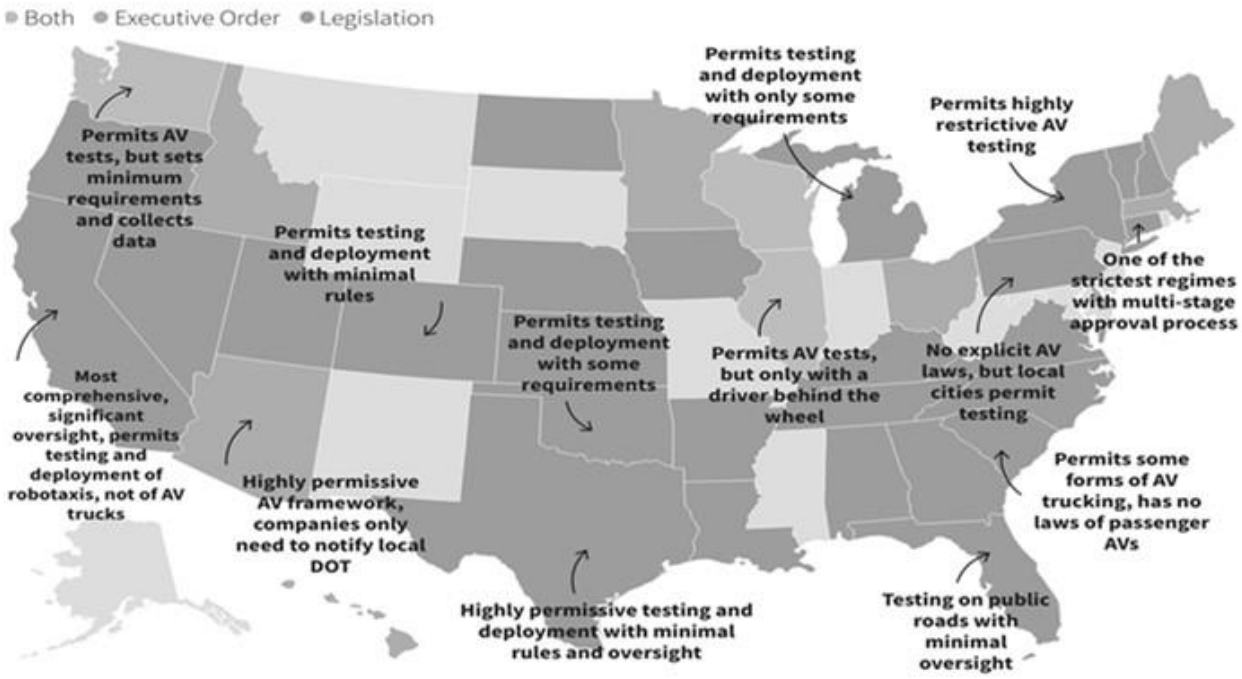
The Current State of AV Law and Regulation: A Fireside Chat – Ariel Wolf and Ian Adams

This conversation was designed to provide participants with an overview of federal and state law and regulation, as well as trends in the development of each. To do so, Mr. Adams conducted an informal interview with Mr. Ariel Wolf, chair of Venable LLC’s Autonomous and Connected Mobility Group, general counsel to the Autonomous Vehicle Industry Association, and former DOT appointee. Given Mr. Wolf’s obvious normative policy preferences, the chat began by inviting the audience to interject when they identified areas of disagreement.

Substantively, the discussion covered the structure of US law, including the respective roles of federal and state authorities; the pace of evolution in technology-specific law and regulation; and what judges should reasonably expect in terms of binding authority concerning the technology in the future.

During the Q&A session, attendees emphasized the need for policy development for the justice system to handle cases related to autonomous vehicles (AVs) effectively. Participants were particularly concerned about evidentiary considerations related to remote operations that span across different jurisdictions, which they believe require greater attention.

Figure 3: State Regulation of AV



Note: Regulatory state as of June 16, 2022; at least a dozen AV bills are pending across the country
Source: National Conference of State Legislators, Dentons, Reuters research

Panel Discussion: Public Sector Perspective

American Association of Motor Vehicle Administrators (AAMVA) – Marcy Coleman

"Framing the Issues: Legal Challenges in the World of Automated Driving Systems"

AAMVA is a tax-exempt nonprofit organization developing model programs in motor vehicle administration, law enforcement, and highway safety. AAMVA also serves as an information clearinghouse in these areas and acts as the international spokesperson for these interests.

Initially, AAMVA established an AV working group to address issues related to the credentialing, registration and licensing of AV and ADS-equipped CMV. The Working Group is now an established Subcommittee representing state driver licensing agencies, law enforcement (Commercial Vehicle Safety Alliance), and NHTSA and FMCSA. The AV Subcommittee is involved with developing best practice guidelines for SDLAs and original equipment manufacturers on the safe testing and deployment of ADS-equipped vehicles.

Ms. Coleman noted that there are several legal issues that the Subcommittee is dealing with including:

- Definition of a driver and who is responsible for the dynamic driving task when a vehicle is operating at SAE Level 4 or 5.
- If a vehicle is being operated remotely, how is remote driving defined, should remote operators be licensed, how are they cited for violations, what are distracted driving concerns, and what constitutes impaired driving.
- Driver liability – who is at fault in a crash? If a vehicle is being operated at SAE Level 4 or 5, does the event then become a product liability case?
- How to determine the true level of a vehicle's level of automation. Do manufacturers self-certify? Was the vehicle level of automation established during manufacturing or through retrofitting?
- How can it be determined if software updates for an AV or an ADS-equipped CMV have been properly installed and tested?
- How will inspectors determine if AV or ADS systems are operating in accordance with required standards? If a system passes inspection but then fails, who is liable?
- In the event of a crash, how is it determined what AV and ADS systems were operating?
- Who owns data collected from AV and ADS? Who has access to the data and for what purposes can the data be accessed? How is data privacy protected?
- Will the lack of harmonization between jurisdictional traffic laws limit interstate use of AV and ADS-equipped CMV?

Commercial Vehicle Safety Alliance (CVSA)– John Sova

"Enhanced CMC Inspection Standard for Motor Carrier Operations"

The Commercial Vehicle Safety Alliance (CVSA) is a nonprofit organization comprised of local, state, provincial, territorial and federal commercial motor vehicle safety officials and industry representatives. The Alliance aims to prevent commercial motor vehicle crashes, injuries and fatalities and believes that collaboration between government and industry improves road safety and saves lives.

The CVSA has developed the inspection procedures and criteria (known as the North American Standard Inspection Program (NASI)) used by enforcement personnel to inspect approximately 4 million commercial motor vehicle inspections every year throughout North America. The main objective of these inspections is to ensure the large trucks and buses driving on our roadways are operating safely. Specially

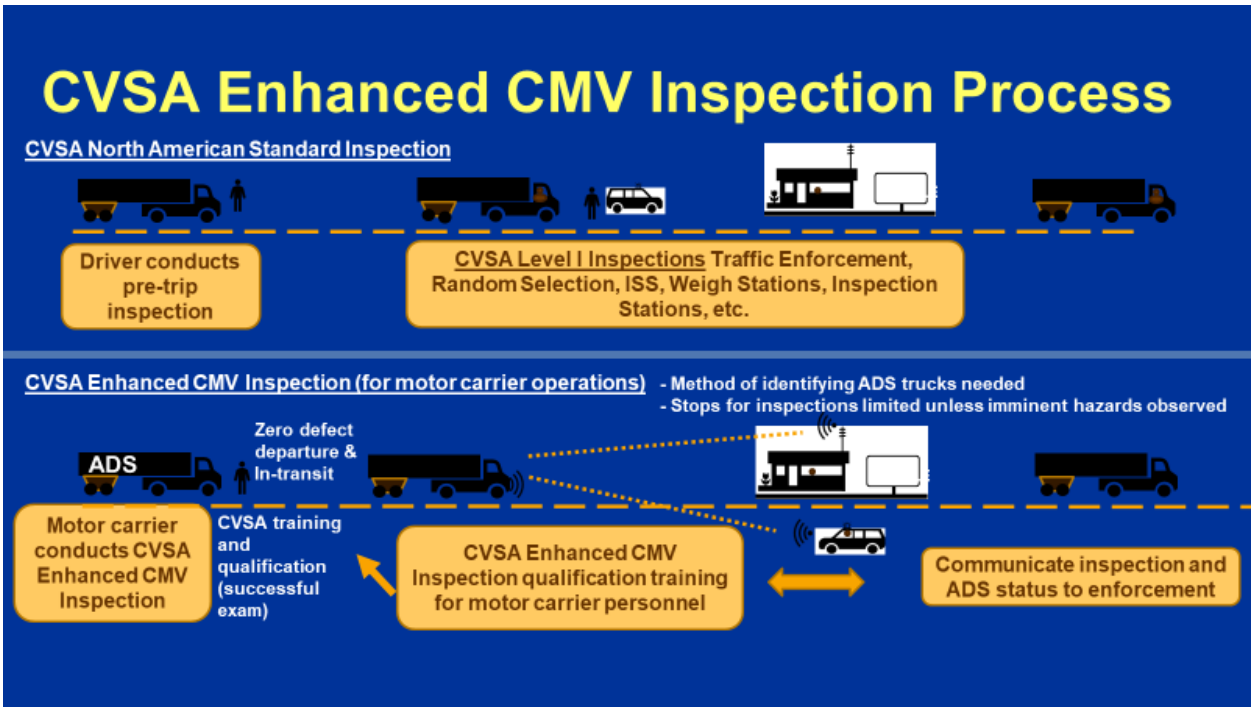
trained inspectors in each state, jurisdiction, territory and province inspect commercial motor vehicles based on NASI inspection procedures and criteria.

Mr. Sova noted that the present roadside enforcement inspection process is not compatible with AV and ADS-equipped CMV. He explained that CVSA is developed an enhanced CMV inspection program for AV or ADS-equipped CMV operating at Levels 4 or 5:

- Vehicles must have a point-of-origin inspection done by a certified inspector prior to beginning a trip. The inspector will be required to have completed a CVSA certification program and the pre-trip inspection of AV and ADS components must show no defect and all systems operate in compliance with established standards.
- The vehicle must communicate a data set wirelessly to enforcement. The data set will indicate in-trip AV and ADS operating status.
- Weigh and inspection bypass will be granted if the data set identifies no imminent hazards, and all systems are operating in compliance with established standards.
- Inspections shall be done in compliance with the CVSA periodic inspection standard.

The figure below illustrates how the enhanced CMV inspection process will be conducted.

Figure 4. CVSA Enhanced Inspection Process



Mr. Sova explained that a Beta Test of the Enhanced Commercial Motor Vehicle Inspection program, including the certification of personnel to conduct the point-of-origin pre-trip inspection, was successfully conducted in 2022. Participants included ADS developers, motor carriers, enforcement personnel and CVSA staff. He concluded by noting that the most significant challenge facing enforcement is the lack of standards for AV and ADS-equipped CMV. He stated that the development of standards establishing minimum system performance is necessary for enforcement to conduct roadside safety inspections and enforcement actions.

Maryland Connected and Automated Vehicles (CAV) - Nanette Schieke, Maryland Motor Vehicle Administration (MVA)

The State of Maryland has established a CAV Working Group under the Maryland Department of Transportation. The group, which is coordinated by MDOT's Maryland Motor Vehicle Administration (MVA) includes a diverse group of stakeholders from industry, highway safety, all levels of government agencies, information technology, public safety, economic development, and elected officials. The CAV Working Group is divided into four subgroups for Freight, Emergency Responders, Policy, and Technology.

I(n the year 2020, Maryland published the "Maryland Connected and Automated Vehicle Strategic Framework"[1]. The five areas of focus in this Framework are: 1. Public Education and Outreach 2. Planning and Policy 3. Early Deployment and Testing 4. Infrastructure 5. Workforce. For each of the key areas, this Framework provides a brief overview of activities to date, followed by a call to action with a set of high-level objectives that empowers stakeholders to work together to advance CAV strategies that align with the objectives.[2]

Ms. Schieke presented a diagram (Figure 2), specifically developed for Maryland that illustrates the complexity of the emerging AV and ADS technologies and the number of stakeholders involved at the national and state level. The diagram also highlights the challenges states face in developing a statutory and regulatory framework for AV and ADS.

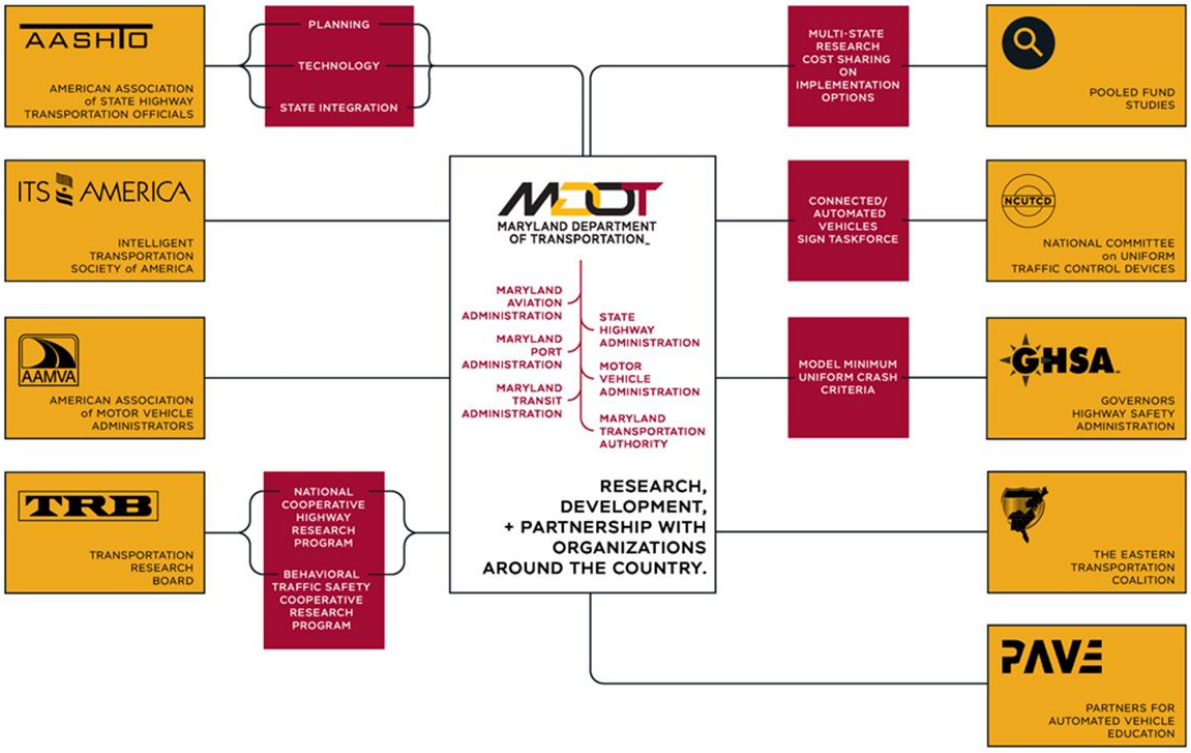
To facilitate the on-road testing of highly automated vehicles, personal delivery devices, and Commercial Motor Vehicles (CMV), Maryland has established a permitting process. The State has developed a list of closed-loop testing sites, each with detailed specifications, and built a CAV website (https://cav.mdot.maryland.gov/collaboration-with-industry/) containing links to permit applications and test site locations. As part of the permit process, the applicant is required to submit a Safety and Compliance Plan that includes assurances from the manufacturer / entity that the vehicle:

- Operational Design Domain (how & where HAV is supposed to function and operate)
- Proposed test location(s) (areas or corridors)
- Proposed transport plan for movement from storage site(s) to test location(s)
- Emergency response – Cut-Off Switches
- Self-certification that the SAL points have been addressed.

[1] The Framework is available at the following link: chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/https://cav.mdot.maryland.gov/wp-content/uploads/2022/10/Maryland-CAV-Strategic-Framework.pdf

[2] Maryland CAV Strategic Framework, p. 11

Figure 5. State of Maryland: Representative Partnerships



Applicants are also required to self-certify that:

Vehicles

- All vehicles used in an HAV testing program are required to meet all applicable Federal Motor Vehicle Safety Standards or are subject to an exemption from such standards by the National Highway Traffic Safety Administration (NHTSA).
- Submit a copy of the Safety Assessment Letter submitted to NHTSA for the vehicle(s) being tested; OR submit information regarding the Operational Design Domain of the HAVs and Self-Certification to applicable safety standards.
- Provide reasonable measure of information that test vehicles that have been previously tested under controlled conditions.
- Any leased vehicle to be used for HAV testing will require a letter of acknowledgement from the leasing company identifying the vehicle being used.

Operators

- Each operator must be properly licensed in his/her jurisdiction of residence. If an operator is licensed outside of Maryland, a certified copy of the driver's record will be necessary.
- Each operator has completed HAV safety training.
- Each operator must follow the rules of the road.
- **No vehicle used in the HAV testing program may be operated in modes SAE 3 through SAE 5 except by an approved licensed operator.**
- **Liability**

- Applicant shall provide evidence of the ability to satisfy judgement(s) for damages resulting in personal injury, death, or property damage in the form of an insurance policy for not less than 5 million U.S. dollars from an insurance company licensed to do business in Maryland or a surety bond.
- Applicant accepts liability for all damages resulting from their vehicles and drivers/operators of those vehicles.
- **Planning/Reporting**
- Abide by safety and compliance plans for testing vehicles on roadways open to public travel.
- Report any crashes in the test vehicles by close of business the next business day following a crash.
- **Regular reporting and renewal period as agreed.**
- Identification of any wireless communication components of the test, operating in either licensed or unlicensed spectrum (unlicensed components shall be compliant with Title 47 Code of Federal Regulation, Part 15 (47CFR15).
- Right to cancel by either party at any time.

The State of Maryland has provided guidelines for law enforcement personnel to follow during roadside enforcement actions involving Highly Automated Vehicles (HAVs). Additionally, the state has developed a crash reporting form for such events. Maryland has also issued specific guidelines for Personal Delivery Devices, which require filing an Emergency Response Plan with the state at least 30 days prior to starting operations. Ms. Schieke noted that Maryland is working to address issues related to AV and ADS-equipped CMV including:

- Importance of Terminology – what is the correct term to use - CAV, ADS, ADAS, HAV, HACV
- Definition of "driver" – how are AV and ADS integrated into existing motor vehicle laws.
- Definition of vehicle "dealer" or "manufacturer" to establish responsibility for vehicle operation and software updates.
- Consumer protections – sensors and cameras
- Registration – add in an additional data field for AV or ADS, but how would the state identify level of autonomy?
- Insurance issues – product liability; regulators react based on filings; issuing companies? Should the state build liability information (OEM/owner) in registration? – percentage of liability assigned to OEM/owner, develop specific scenarios.

Panel Discussion: Private Sector Perspective

American Transportation Research Institute (ATRI) – Dan Murray

"Industry Perspective on Autonomous Trucks"

ATRI is the trucking industry's not-for-profit research organization. The American Transportation Research Institute (ATRI) has been engaged in critical transportation studies and operational tests since 1954. ATRI is a 501(c)(3) not-for-profit research organization headquartered in Washington, D.C., with offices in Atlanta, Minneapolis, and Sacramento.

ATRI is an organization that focuses on transportation research, with a special emphasis on the trucking industry's essential role in maintaining a safe, efficient and sustainable transportation system. The research areas that ATRI focuses on include Congestion and Mobility, Economic Analysis, Safety and Security, Technology and Operations, Environment, and Transportation Infrastructure.

Mr. Murray noted that between 2005-2011 to 2012-2019, the number of "nuclear verdicts", verdicts against trucking fleets with awards of $1,000,00 or greater, involving the trucking industry had increased from 79 to 265, a 335% increase.[3] The impact of the increase in nuclear verdicts is shown in a significant increase in the costs of insurance over time. Mr. Murray noted that between 2010 and 2020, insurance premiums for the trucking industry have increased from $0.059 to $0.087, an increase of 47%.[4]

According to a recent report, premiums have increased for all fleet sizes and sectors. Small fleets are paying more than three times the amount of very large fleets on a per-mile basis. Additionally, small fleets are paying more than double the amount per mile than large fleets, which are paying almost double the amount per mile than very large fleets. There are multiple reasons for these increases, but the report identified increased payouts resulting from nuclear verdicts and a 50% increase in incurred losses between 2015 and 2019 as significant factors contributing to the rise in premiums. Mr. Murray concluded by referencing an ATRI study "Redefining the Role of Government Activities in Automated Trucking"[5]. He pointed-out that while industry believes that AV and ADS-equipped CMV offer significant productivity and safety benefits for the trucking industry, at present states are developing a disparate regulatory framework in the absence of Federal guidance. He further indicated that a primary concern of the industry is "to consider how to allocated liability among AV owners, operators, passengers, manufacturers and other entities when a crash occurs: determine who must carry motor vehicle insurance; consider rules and laws allocating tort liability".[6] The report reveals that liability issues are one of the least developed aspects of AV technologies and motor carriers are reluctant to deploy AV and ADS given the uncertainty of liability exposure in the event of a crash.

National Association of Mutual Insurance Companies (NAMIC) – Anthony Cotto

The NAMIC is the largest property and casual (P/C) insurance company trade association representing over 1,500 local, regional and national mutual insurers. The association supports regional and local mutual insurance companies on main streets across America along with many of the country's largest national insurers. NAMIC member companies write $391 billion in annual premiums and together account for 68 percent of homeowners, 56 percent of automobile, and 31 percent of the business insurance markets.

Membership in the NAMIC is not restricted to mutual insurance companies alone. Stock insurance companies, reinsurance companies and industry vendor companies may also apply to become associate members. More than 450,000 people are employed by the NAMIC member companies.

During his presentation, Mr. Cotto provided an overview of risk-based pricing where insurers assess risk factors and develop rates accordingly. He mentioned that risk-based is the standard industry practice and the assessment of risk factors is primarily data-driven. He pointed out that insurers consider potential

[3] See: American Transportation Research Institute, "Understanding the Impact of Nuclear Verdicts on the Trucking Industry", June 2020. https://truckingresearch.org/2020/06/understanding-the-impact-of-nuclear-verdicts-on-the-trucking-industry/

[4] Source: https://www.truckinginfo.com/10161860/atri-report-takes-on-rising-trucking-insurance-costs

[5] Source: chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/https://truckingresearch.org/wp-content/uploads/2020/02/ATRI-Redefining-Role-of-Govt-Regs-in-AT-01-2020.pdf

[6] Source: chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/https://truckingresearch.org/wp-content/uploads/2020/02/ATRI-Redefining-Role-of-Govt-Regs-in-AT-01-2020.pdf, p.30.

liability when making decisions and further that assessing and allocating liability are the critical components of every P/C claim. He indicated that determining the details of crash liability can be complicated and that auto tort cases account for nearly two-thirds of all tort cases.

Current traffic codes and insurance practices are built on the understanding that the person behind the wheel performs all dynamic driving tasks. With the growing deployment of AV and ADS-equipped CMV, the industry is grappling with several questions raised by the new technology that impact risk assessment and the risk-based pricing model:

- Did the human (safety) driver exercise due care in relying on the vehicle's operating system?
- Did the safety driver fully understand his or her responsibilities?
- What training did the safety driver receive?
- How can it be determined if the system was operating in accordance with design specifications?
- How can it be determined if the system was properly engaged?
- How will the sudden emergency doctrine be applied to AV and ADS vehicles?
- How will join and severable liability be determined?
- Who is assigned responsibility if an AV or ADS system encounters a circumstance outside of existing operational boundaries?

Mr. Cotto stated that NAMIC believes states should retain the regulation of insurance for vehicles and operators, and that states should retain the authority to define and address ADS liability issues in state/tort law and regulations., and that states and Federal authorities should establish clear and workable data security and privacy standards for AV and ADS. NAMIC is of the opinion that additional research is needed to develop a better understanding of AV and ADS safety and potential risks. Mr. Cotto recommended that this research include analysis of such issues and human-machine interfaces, privacy, cybersecurity, and software functionality.

In conclusion, Mr. Cotto emphasized the need for greater collaboration between Federal and state governments and the private sector. He also suggested that legislators and regulators should receive insurance-specific education to ensure that they are well-informed when making policy decisions.

National Association of Criminal Defense Lawyers (NACDL) – Clare Garvie

The NACDL was established in 1958 as the National Association of Defense Lawyers in Criminal Cases. NACDL's mission is to serve as a leader, alongside diverse coalitions, in identifying and reforming flaws and inequities in the criminal legal system, and redressing systemic racism, and ensuring that its members and others in the criminal defense bar are fully equipped to serve all accused persons at the highest level.

The NACDL's Fourth Amendment Center offers direct assistance to defense lawyers handling cases involving new surveillance tools, technologies and tactics that infringe on the constitutional rights of people in America. The Center is available to help members of the defense bar in bringing new Fourth Amendment challenges, providing a range of support: from training and resources to expert consultation and direct litigation, all free of charge.

The NACDL Foundation for Criminal Justice conducted a symposium in 2016 on "The Fourth Amendment in the Digital Age"[7]. Recognizing the importance of Fourth Amendment protection in the digital age and the impact technology has had on traditional law enforcement practices, the Symposium

[7] Source: https://www.nacdl.org/Document/FourthAmendmentintheDigitalAge

was conducted to identify and develop recommendations covering policy, legislative, educational, and legal strategy to protect Fourth Amendment rights. The policy proposals included:

- Developing consistent policies to cover the use of the new technologies.
- Promote technological solutions such as encryption.
- Protecting data privacy. This includes identifying how data will be collected, what data will be collected, how data will be stored and accessed, and how data will be used.

During her presentation Ms. Garvie discussed the issues of the deployment of AV and ADS-equipped CMV, and the importance of protecting the Fourth Amendment rights. While the wireless exchange of data between AV and ADS-equipped CMV and law enforcement at roadside is necessary to ensure safe operations and detect imminent hazards, it is crucial for the industry, ADS developers and enforcement to identify the particular data elements necessary for enforcement purposes. Trucking companies routinely collect data used to monitor vehicle performance, identify maintenance needs, and schedule preventive maintenance. However, the industry has expressed concern about protecting this proprietary data and ensuring that only data necessary related to safety and regulatory compliance is provided at roadside.

Additional concerns involve:

- How will data collected at roadside be used by law enforcement. Issuing a weigh station bypass if no imminent hazards are identified is consistent with existing electronic screening programs. An issue that needs to be addressed is that data collected on AV and ADS performance can be used for enforcement purposes and if so, in what circumstances.
- How will data privacy be protected. The data exchanged at roadside is proprietary to the particular company operating the vehicle, and the data exchanged needs to be protected and not accessible to competitors or hackers.
- Establishing protocols governing data access and storage. These would cover who can access data, how access is controlled, how data will be stored, and how long data will be stored.

Facilitated Breakout Sessions

Technology and the Law

Session attendees identified the need for legislative guidance as a prominent challenge facing the continued introduction of AV technology into society. Undoubtedly, the influx of these new tools will increase litigation even in the absence of appropriate legislative guidance, whether in the civil or criminal realm. As a result, there is a clear and articulated desire for greater understanding of how the technology works, how the technology works and the provision of statutory guidance to adjudicate cases appropriately. Participants identified several areas of concern beginning with the “pacing” problem, which addresses the speed at which technology is improving and advancing as juxtaposed against the inability of the legislative and judicial system to keep pace through the enactment of laws in response to these advancements. Participants also noted that without clear statutory guidance on AI and AV related cases, society could expect to see a “patchwork” of precedent based on anecdotal circumstances and experiences.

It is highly unlikely that judges, magistrates, and hearing officers could become experts in this highly technical field of AV. However, since this technology has infiltrated several aspects of driving, there is a clear need for judicial education in this area to inform decision-making. Participants identified the following overarching priorities in addressing the complex issues presented by the intersection of law and technology:

- **Vernacular:** Establishing and familiarizing the judiciary with a common AV lexicon for use in adjudicating matters.
- **Evidence:** Resolving issues related to evidence type, collection/access, retention and chain of custody when dealing in a highly digitized environment. This includes but is not limited to issues surrounding evidence control, ownership, access and storage pricing.
- **Analogy Application:** In the absence of clear guidance or articulated legislation, there is an increased likelihood that a "patchwork of precedent" will be created largely because of judges relying upon analogous circumstances or experiences to resolve AV litigation, whether civil or criminal.
- **Testimony:** Creating or setting standards to determine witness expertise in the area of AV's, even in light of the ever-changing technological landscape.
- **Conflict of Laws Resolution:** Addressing conflicts which could arise between existing CDL statutory regulations and ADS regulations that may create confusion or conflict, such as distracted driver regulations related to cell phone use while operating a CMV.
- **Vehicle Design Elements:** Creation of national standardization of vehicle design elements to assist in readily identifying AV's as well as operational levels. This can include license plate preambles (ex. AV1, AV2, AV3, etc.) and generally accepted design elements, such as illuminated steering wheels to indicate active AV engagement. Stakeholder Engagement and Education

The participants noted that the emergence of AV and the potential societal impacts represent a unique challenge for the judiciary. Therefore, the participants identified a key priority, which is the development of a baseline educational program designed to help judges gain an understanding of AV technologies and operations. Furthermore, they recommended conducting a judicial survey to establish a baseline understanding of AV and use the results of the survey to inform the educational program. The educational program should cover topics such as the SAE Levels of Driving Automation, and providing demonstrations of AV, in-person or virtual, can be beneficial. Participants emphasized that the educational program should focus on faculty development and "training the trainer" to expand the reach to a wider audience.

Stakeholders identified a second priority, which is the development of common AV terminology and definitions. They suggested that conducting a state-by-state analysis of existing terms and definitions should be done to establish a baseline and identify existing commonalities. Participants noted that such an analysis could be used to support the development of common terminology and definitions.

Additional priorities identified by participants included:

- Development of a judicial bench card on AV technology and terminology for judges to use as a reference as the number three priority. The bench card would be digital and include a search function.
- Continuing judicial education on AV. There was much discussion about if this training should be mandatory and or if state judiciaries should designate judges to specialize in hearing AV cases.
- The need for states to improve the coordination of CDL program activities and engage in stakeholder outreach. Participants suggested that states establish CDL specific Advisory Committees to better coordinate a state CDL program from roadside through the adjudicatory process to state driver licensing agency updates of a CDL holder's record. Participants noted that the given the complexity of challenges and issues raised by AV, bringing together stakeholders to collectively resolve these challenges would support the integration of multiple stakeholder requirements and promote the coordination of a state's CDL programs.

- Participants emphasized the for outreach to all stakeholders involved with the CDL program at the national and state levels. Suggestions included working with State Judicial Educator and national associations to promote AV education.

Safety Inspection and Enforcement

The top priorities identified by participants included definitions of terms, performance standards, enforcement procedures, and cybersecurity.

One of the main issues that was identified as a priority was establishing a clear definition of a driver for an AV or ADS-equipped CMV. Discussions on this topic focused on:

- How would law enforcement determine who is responsible for dynamic driving tasks, a safety driver or the ADS? If the latter, are ADS operators or developers responsible?
- Who would receive a citation in the event of a roadside enforcement action?
- What type of credential would be issued to permit the operation of an AV or ADS-equipped CMV?
- What type of identifiers will be issued to an AV or ADS-equipped CMV?

Participants noted that there was a need for performance standards to support enforcement:

- What are the minimum safety performance standards for AV or ADS-equipped CMV?
- What are the performance standards for safety drivers?

The discussion on performance standards overlapped significantly with the discussion on how enforcement will be conducted:

- How will enforcement determine that the vehicle is meeting these standards?
- How will enforcement determine that all software updates have been installed and are operational?
- What type of certification will be provided establishing the vehicle's level of automated driving?

Data privacy and cybersecurity were also raised as issues:

- How will data exchanged between the vehicle and roadside enforcement be protected?
- What data will enforcement personnel need to ensure safety and conduct inspections?
- Who will have access to this data and how will the data be used? Industry expressed concerns about proprietary data a company might collect for preventive maintenance being used for an enforcement action.
- What information will judges have access to when hearing cases?

Operator Responsibility and Liability Issues

The primary issue discussed by participants concerned the assignment of liability. Participants suggested that AV and ADS-equipped CMVs will not be deployed in meaningful numbers in the absence of clarity about who is liable in the event of an accident, since uncertainty will be reflected in the associated price of risk and insurance.

According to the participants, there is currently no specific set of laws governing autonomous vehicles (AV) and advanced driver assistance systems (ADS) equipped commercial motor vehicles (CMVs). However, they noted that the existing standards of reasonability might be adequate to handle disputes in most cases. The only requirement is that the judges should be better informed about the expectations surrounding the technology. Participants highlighted the importance of defining the term of "driver,"

"Who put the vehicle in operation?" for ascertaining responsibility. The discussion focused on determining who, or what, is assigned responsibility for the dynamic driving tasks (DDT) when a vehicle is operating at Levels 3 and 4 and who is, therefore, liable in the event of an incident. For example, if a safety driver recognized that the vehicle's operating software was not trained to recognize a certain event and the safety driver did not have adequate time to make the necessary correction (participants referred to this as the 10 seconds, who will be liable if this results in a crash or other incident?

The participants emphasized the importance of education and outreach programs for judges to develop the knowledge necessary to fairly and objectively adjudicate cases involving AV and ADS-equipped CMVs. These programs will also support managing expectations about how AV and ADS-equipped CMVs will be deployed and operated.

Human responsibility in the operation of AV and ADS was also identified as an issue impacting potential liability. The discussion focused on determining what level of training would a safety driver need to operate the vehicle; who will provide this training; what are safety driver responsibilities when a vehicle is operating at Levels 3 and 4.

The question of determining the manufacturer's liability (product liability) was also identified as a significant issue. Participants identified issues such as who is liable in the event of a system or system component failure that results in a crash; how will manufacturers ensure that software updates are properly installed and working; what happens if a manufacturer stops supporting a particular technology or software.

Participants noted that the insurance industry will face significant challenges in conducting risk assessments and establishing rates in the absence of a statutory or legal framework addressing these issues.

Stakeholder Priorities

Stakeholders overwhelmingly identified five top priorities: the need for Federal (FMCSA) guidance; definitional issues (updating the definition of driver); establishing a framework for and the need for assigning liability; and judicial and stakeholder outreach and education on AV and ADS.

With respect to FMCSA guidance, stakeholders expressed concern that as states adopt a "patchwork quilt" of statutory frameworks for AV and ADS, the challenge will be to avoid 51 regulatory environments that may impede development and deployment. Stakeholders noted that given the multi-disciplinary nature of identified concerns, a collaborative effort to develop a statutory framework under FMCSA guidance would help promote statutory and regulatory harmonization.

As with an expressed need for FMCSA guidance, stakeholders collectively agreed that establishing a definition of driver is critical for moving forward with developing the AV and ADS regulatory framework. Defining the entity responsible for dynamic driving tasks (the AV or ADS systems, the safety driver) will help define the liable party in the event of an incident or crash. A standardized definition will also guide the trucking industry, developers, and manufacturers on their potential risk exposure and what they need to do to mitigate it. A guide will in turn provide the insurance industry with the information needed to apply risk-based pricing to determine insurance premiums.

The discussion on establishing a definition of driver included a discussion on the need to establish what training and/or certification a safety driver is required to complete and define their responsibilities in vehicles operating at Levels 4 and 5. Driver role and responsibility definition for lower levels of automation (Level 2 and Level 3) are also needed in the short run.

In discussing the need for a defining the entity considered to be the driver in an AV or ADS-equipped CMV, stakeholders also indicated that the issue of determining liability in the event of an incident or crash presented a significant challenge. Stakeholders recognized that to a certain degree, liability issues would be addressed through case law. Stakeholders stated that establishing a framework for assigning liability would provide guidance and direction with assessing risks and developing mitigating strategies. The insurance industry stakeholders indicated this would be a critical factor, as previously noted, in applying risk-based pricing to setting rates.

Stakeholders expressed consensus on the need for judicial and stakeholder outreach and education. This included consensus on the need to educate the judiciary and stakeholders on AV and ADS technologies and continue to identify issues and document issue resolution best practices.

Data privacy also was identified as an inter-disciplinary concern. Issues discussed included cybersecurity (protecting AV and ADS systems from being hacked, ensuring the security of wireless data exchange between automated CMVs and roadside) and protecting Fourth Amendment rights in the digital age. As part of the latter discussion, stakeholders also noted that there was a need to set purpose limitations on the collection and use of data.

Law enforcement emphasized the need for the development of AV and ADS performance standards. These standards are needed to support roadside inspection and safety actions and determine if an AV or ADS-equipped CMV is operating safely or is experiencing a system failure that represents an imminent hazard.

Table 1 presents a summary of stakeholder priorities identified for each breakout session.

Table 1: Stakeholder Priorities

Priorities for each Breakout Session	Technology and the Law	Stakeholder Engagement and Education	Safety Inspection and Enforcement	Operator Responsibility and Liability Issues
FMCSA Guidance	✓	✓	✓	✓
Definitional Issues – driver	✓	✓	✓	✓
Establish performance standards for enforcement			✓	
Judicial (and stakeholder) Education	✓	✓	✓	✓
Establish a framework for assigning liability	✓	✓	✓	✓
Purpose limitations on data collection and use			✓	
Data Privacy	✓	✓	✓	✓
Role of Safety Driver			✓	✓

Glossary

A comprehensive list of the technical terms related to automated vehicles and automated driving systems, in alphabetical order, with their definitions:

1. **Actuation:** The system's actions or reactions based on computing decisions, such as steering, accelerating, or braking.
2. **ADS Deployment Compliance:** Legal and safety standards that ADS-equipped vehicles must meet before being deployed on public roads.
3. **ADS Health & Status:** A system check to ensure the health and operational capability of the Automated Driving System in a commercial vehicle.
4. **ADS-equipped CMV:** Commercial Motor Vehicle that is equipped with an Automated Driving System.
5. **Automated Driving Systems (ADS) Liability:** Legal considerations regarding responsibility and accountability in the event of malfunctions or accidents involving ADS.
6. **Autonomous Commercial Motor Vehicle (CMV) Evaluation Program (ACE):** A program sponsored by FMCSA to evaluate and test automated commercial vehicles, particularly focusing on safety inspections.
7. **Autonomous Driving Software Stack System Architecture:** The layered structure of software modules and components that handle various autonomous driving functions, from sensing to decision making to control.
8. **Autonomous Trucking Regulations:** Specific laws, guidelines, and standards set by regulatory bodies for the operation and safety of autonomous trucks.
9. **Behavior Planning:** Making decisions in response to dynamic traffic conditions.
10. **Camera:** Visual sensors that capture images of the vehicle's surroundings, allowing the software to identify and interpret objects, signs, lanes, and other elements.
11. **CARMA:** A decision-making and control platform utilized by FMCSA for testing autonomous systems.
12. **Closed-loop Testing:** Testing in a controlled environment where the vehicle can receive feedback from the environment and make adjustments.
13. **Computing (perception, decision making, and planning):** The processes the AV software goes through, such as identifying objects (perception), deciding actions based on the environment (decision making), and charting the vehicle's path (planning).
14. **Connectivity:** Refers to the technologies that allow vehicles to communicate with each other, infrastructure, devices, and networks.
15. **Control Algorithms:** Mathematical models and techniques used to control vehicle behavior, such as steering, accelerating, or braking.

16. **Convoys:** Multiple trucks driving in proximity where the lead truck controls the following trucks, often to improve fuel efficiency and safety.
17. **Cross-Jurisdictional Operation:** Legal and regulatory challenges when automated vehicles cross from one jurisdiction (like a state or country) to another with different rules.
18. **Cybersecurity Standards:** Regulations and guidelines to protect automated vehicles from cyber-attacks and unauthorized data breaches.
19. **Data Protection and Privacy:** Legal considerations regarding the storage, transmission, and processing of user and environmental data by automated vehicles.
20. **Dead Reckoning:** A process of estimating current position based on a previously known position, often used when GPS data is temporarily unavailable.
21. **Decision Making:** The process through which an autonomous vehicle decides on the best action to take given its perception of the environment.
22. **Deep Learning:** A type of machine learning characterized by algorithms inspired by the structure and function of the brain called artificial neural networks.
23. **DSRC (Dedicated Short Range Communications):** A wireless communication channel specifically designed for automotive use.
24. **Dynamic Driving Task:** All of the real-time operational and tactical functions required to operate a vehicle in on-road traffic.
25. **Edge Case:** A problem or situation that only occurs at an extreme operating parameter.
26. **Electronic Confirmation:** A digital method of verifying or confirming specific data or status of a system.
27. **Electronic Messaging:** Communication methods that involve the transmission of messages via electronic means, like signals transmitted to the vehicle.
28. **Emergency Lights/Siren Pull Over or Move Over:** The vehicle's response mechanism to yield to emergency vehicles by either pulling over to the side of the road or shifting lanes.
29. **End-to-End Learning:** A method in which autonomous vehicles are trained to manage the entirety of the driving task in a unified way, rather than breaking it down into individual components.
30. **Enhanced Pre-trip Inspection:** A thorough examination of the vehicle and its systems before a trip to ensure safe operation, with added checks specific to ADS.
31. **Environment Perception:** How an autonomous vehicle perceives its surroundings using sensors like lidar, radar, and cameras.
32. **Ethical Considerations in ADS:** Philosophical and legal discussions about how automated vehicles should behave in morally complex scenarios.
33. **Event Data Recorder (EDR):** A device that collects data related to vehicle crashes or accidents, sometimes referred to as a "black box."

34. **Fail-Safe:** A system or feature that, in the event of failure, responds in a way that will cause minimal harm.
35. **Fallback-ready User:** A human user who is able to take over the driving task if the ADS requests the handover.
36. **Federal Motor Vehicle Safety Standards (FMVSS):** U.S. national standards for motor vehicle equipment to ensure safety.
37. **Functional Safety:** Part of the overall safety of a system or piece of equipment that depends on the system or equipment operating correctly in response to its inputs.
38. **Functional Safety Assessment:** A validation and verification process ensuring that the automated driving system functions safely under a range of conditions.
39. **Geofencing:** A virtual geographic boundary, defined by GPS or RFID technology, by which an AV can be restricted to operate within.
40. **GPS:** Global Positioning System, a satellite-based navigation system that provides geolocation and time information.
41. **Haptic Feedback:** Use of touch sensations (e.g., steering wheel vibrations) to convey information to the driver.
42. **HD Maps (High-Definition Maps):** Extremely detailed maps used by autonomous vehicles for precise navigation.
43. **Human Machine Interface (HMI):** The interaction points between a human and a machine, like displays or touchscreens in a vehicle.
44. **Inertial Measurement Unit (IMU):** An electronic device that measures and reports an object's velocity, orientation, and gravitational forces.
45. **Inspection/Weigh Station "Pull-in or Bypass":** Instructions given to autonomous commercial vehicles for them to either stop at an inspection/weigh station or bypass it.
46. **Lane Keeping Assistance (LKA):** An autonomous driving feature that helps drivers stay within their lane by making slight adjustments to the vehicle's trajectory.
47. **Lateral Control:** The ability to control a vehicle's side-to-side movements, mainly related to steering.
48. **Liability Framework:** A legal structure determining responsibility in the event of damages or injuries caused by autonomous vehicles.
49. **LiDAR:** A method for determining distances by illuminating the target with laser light and measuring the reflection, commonly used in autonomous vehicles for environment perception.
50. **Localization:** The ability of an autonomous vehicle to determine its position within its environment.
51. **Longitudinal Control:** The ability to control a vehicle's forward and backward movement, relating to acceleration and braking.

52. **Machine Learning (ML):** A subset of artificial intelligence involving algorithms that allow computers to improve their performance on a task through experience.
53. **Machine Perception:** The ability of a system to interpret data in a way that is similar to how humans use their senses to understand the world.
54. **Mandatory Reporting:** A requirement for certain types of accidents or incidents involving autonomous vehicles to be reported to regulatory authorities.
55. **Minimal Risk Condition:** A state to which an automated driving system brings the vehicle if it can no longer operate safely, like safely pulling over and stopping.
56. **Object Detection, Tracking, and Classification:** The ability of an AV to identify, monitor, and categorize objects in its environment.
57. **Object Recognition:** The ability to recognize and identify different types of objects in the environment, such as vehicles, pedestrians, and signs.
58. **Onboard Diagnostics (OBD):** A vehicle's self-diagnostic and reporting capability.
59. **Operational Design Domain (ODD):** The specific conditions under which a given autonomous system is designed to operate, like urban environments or highways.
60. **Over-the-Air (OTA) Updates:** Remote software updates sent wirelessly to vehicles.
61. **Path Planning:** The process of defining a path or route for the vehicle to follow based on the environment and current conditions.
62. **Platooning:** A group of vehicles that travel closely together, often using technology to synchronize their movements.
63. **Predictive Algorithms:** Algorithms that anticipate and predict future events or conditions based on current and past data.
64. **Radar:** A system using radio waves to detect the distance, angle, or velocity of objects.
65. **Redundancy:** Duplicate systems or components designed to continue operation if one part fails.
66. **Remote Driver:** A human operator who can control a vehicle from a distance, usually in emergency situations.
67. **Remote Operator:** An individual not physically present in the autonomous vehicle but who can supervise or control its operations.
68. **Route Planning:** The process of determining the best route for a vehicle to reach its destination.
69. **Safety Assurance:** Processes and standards in place to ensure the safe operation of a system.
70. **Safety Driver:** A human present in an autonomous vehicle during testing who can take control if necessary.
71. **SAE J3016 Standard:** A classification system by the Society of Automotive Engineers (SAE) that defines levels 0 to 5 of driving automation.

72. **SAE J3216:** A standard by the Society of Automotive Engineers (SAE) that provides terms and definitions related to automated driving.
73. **Scenario Description Language for Autonomous Driving:** A standardized language used to describe various traffic situations and scenarios for testing autonomous vehicles.
74. **Semantic Segmentation:** The process of classifying every pixel in an image into a category, often used in image recognition tasks for autonomous vehicles.
75. **Sensor Calibration:** The process of adjusting sensors to ensure accurate data collection.
76. **Sensor Fusion:** Combining data from multiple sensors to get a more accurate understanding of the environment.
77. **Simultaneous Localization and Mapping (SLAM):** A technique that allows an autonomous vehicle to map its environment while also keeping track of its own position.
78. **Simulation Testing:** Testing of autonomous vehicles in a virtual environment.
79. **Situation Awareness:** The ability of an autonomous vehicle to understand its environment and its relation to it.
80. **Teleoperation:** The remote control of a machine or vehicle by a human operator.
81. **Testing and Deployment Permits:** Permissions granted by regulatory bodies for companies to test or deploy autonomous vehicles on public roads.
82. **Third-party Certification Bodies:** Independent organizations that certify the safety or compliance of products or systems.
83. **Threat Model:** A structured representation of all the information that affects the security of an application, system, or environment.
84. **Trajectory Planning:** Determining the future path of a vehicle based on current motion and desired state.
85. **Type Approval/Certification:** A certification process where a product, component, or system meets specified standards.
86. **Ultrasonic Sensors:** Sensors that use ultrasonic waves to detect objects and measure distances.
87. **Validation:** Ensuring the system works as intended and meets specified requirements.
88. **Vehicle Dynamics:** The study of how forces affect vehicle motion.
89. **Vehicle Sensing:** The array of sensors that allow a vehicle to perceive its surroundings.
90. **Vehicle-to-Everything (V2X):** Communication systems that allow vehicles to communicate with any entity that may affect the vehicle, including infrastructure, other vehicles, and pedestrians.
91. **Vehicle-to-Network (V2N):** Communication systems that connect vehicles to cellular or local network infrastructure.
92. **Waypoint:** A specific coordinate or location that a vehicle uses for navigation.

93. **Yaw Rate:** The rate at which a vehicle rotates around its vertical axis, often used in vehicle stability systems.