ACKNOWLEDGMENT

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C/ADS Legal and Regulatory Prioritization and Harmonization Assessment

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Executive Summary

The fundamental objective of this project was to help states, especially agency leadership in the transportation domain, recognize the critical laws and regulations that may need to be changed or modified as connected and Automated Driving System (C/ADS)-equipped vehicles are deployed. Industry sectors engaged in C/ADS deployment, legal practitioners, and state legislatures recognize that current laws and regulations must be addressed in a comprehensive, yet flexible way to ensure safety and reap the anticipated societal benefits of C/ADSs, while at the same time anticipating many unknowns. Unlike implementing traditional legal and regulatory changes, making simple citation modifications to add a new title brand or type of license plate, or instituting an adjustment in fees, fines, or driver sanctions, the changes to C/ADS-related laws are complicated and challenging. Modifying these laws will require changes to basic underpinning concepts and definitions, as well as an understanding of the C/ADS technology and its limitations.

Further, there exist a number of situations in which states, through their motor vehicle agency or department of transportation, may find their needs and those of industry best served by synchronizing their efforts in order to harmonize key regulatory or legislative provisions related to C/ADSs. There may also be areas in today’s vehicle codes and regulations where it is important to harmonize for purposes of supporting the deployment of C/ADSs. In this respect, we assess the advantages, disadvantages, and practicality of harmonizing the approaches to these types of laws and regulations across the country.

Objectives

This analysis set out to 1) identify how and when regulations and laws will need to be modified to facilitate the implementation of C/ADS-equipped vehicles, and 2) identify areas in today's state motor vehicle codes and regulations where harmonization may be important in supporting the deployment of C/ADS-equipped vehicles across the U.S. The following discussion will:

- Delineate the complex interplay between the influence of various vehicle technologies and various vehicle fleets over time and the associated timing for regulatory and legislative reform.

- Identify the regulatory and legal issues related to interoperability.

- Prioritize the progression of laws and regulations based on the short-, mid- and long-term timeframes of driving automation system equipped and C/ADS-equipped vehicles’ entry into the marketplace.

- Determine the degree of harmonization that may be possible in the short, mid-, or long-term.
  - Identify the implications for industry if harmonization of state motor vehicle codes and regulations are not achieved.
  - Present the state-perceived barriers to or enablers for advancing harmonization lessons and models of lessons learned.

- The priority charge of this project is to consider existing laws and regulations that may require modification and/or harmonization; the recommended prioritization provided within primarily draws upon findings from an in-depth legal and regulatory review.
Methods

Due to the complex nature of the C/ADS technology environment, it is useful for states to have a framework to assist them in the identification and prioritization of the changes that will need to be made to critical laws and regulations as driving automation equipped and C/ADS-equipped vehicles are deployed. Additionally, a framework can assist states in their efforts to determine the potential for harmonization of these issues as well as the appropriate means of achieving harmonization. Lessons learned from previous project activities (Loftus-Otway & Gallun, updated 2018; Serian et al., 2017; Wagner et al., 2018) help point to a framework that encourages law and regulation change at the point where technology, stakeholders, and laws, regulations, and policies meet.

Key Assumptions

The following assumptions were considered in developing the progressions of priorities needed for the legal and/or regulatory changes outlined in this report. While these assumptions are expected to hold true, regardless of whether they do or not, state policy makers will still need to consider their impact on legal modifications and should consider them in advancing any legislative or regulatory change.

Assumption #1. NHTSA’s Role and Federal Preemption in Key Areas

NHTSA’s Role and Federal Preemption in Key Areas. It is assumed that NHTSA’s delegation of duties and authorities between the federal government and the states will not change. NHTSA notes that under current law, manufacturers bear the responsibility to self-certify that the vehicles they manufacture for use on public roadways comply with the Federal Motor Vehicle Safety Standards (FMVSS). If a vehicle is compliant within this framework and maintains a conventional vehicle design, there is currently no specific federal legal barrier to a C/ADS being offered for sale or for commercial mobility operations. NHTSA’s Best Practices for State Legislatures (See A Vision for Safety 2.0, NHTSA, 2017) confirms that the states retain their traditional responsibilities for driver licensing (perhaps only until the vehicle is “the driver”), vehicle licensing and registration, traffic laws and enforcement, and motor vehicle insurance and liability regimes. It is assumed that for harmonization reasons, NHTSA will specifically retain FMVSS settings and manufacturer/technology company vehicle and equipment standards. As the trade association Global Automakers have pointed out, the “primary advantage for federal standards related to the design and performance of motor vehicles is to allow manufacturers to design, build and sell one vehicle across all 50 states” (Global Automakers, 2017). States and their associations need to keep this assumption in mind and remain aware of the changing federal landscape. It is recommended that associations like the American Association of Motor Vehicle Administrators (AAMVA) continue their close coordination with NHTSA and that NHTSA continues to engage AAMVA in assisting the states.

Assumption #2. Commercial Driver’s License Standards and Interstate Motor Carrier Preemption

It is assumed that FMCSA will promulgate standards in both of these areas. With the importance of harmonization across state lines and the need for one industry standard and state-to-state uniformity, jurisdictional stakeholders clearly indicated that current standards as codified in the Commercial Motor Vehicle Safety Act of 1986 and accompanying regulations for states should be updated by FMCSA in consultation with the states (Commercial Motor Vehicle Safety Act, 1986). States should, however, review their current laws and regulations that codify these federal requirements and consider modifications that would allow for the easy incorporation of new provisions. This is an area of legal review that should not be overlooked. Many state federal codification statutes are specific to a particular law reference or a particular federal regulation. Some even codify the exact wording of the federal regulation. The key in this evolving environment is to review current federal preemptive statutes and
consider how they may need to be changed in anticipation of changes at the federal level that govern these statutes.

Assumption #3. Focus on Deployment Versus Testing

Further, with the issuance of the Federal Automated Vehicles Policy (NHTSA, 2016) and the subsequent publication, A Vision for Safety 2.0 (NHTSA, 2017), along with the extensive body of current and anticipated laws, regulations, and introduced legislation, the focus of this roadmap document is primarily on driving automation system-equipped and C/ADS-equipped vehicle deployment rather than on testing. While this document does highlight legal requirements associated with both the deployment and testing of C/ADS-equipped vehicles, the most likely application of this resource document is deployment efforts. The varied goals associated with testing in states tend to drive testing legislation, so this project would not be as useful to the end users if the focus was primarily on testing.

Assumption #4 Timeline for Deployment

The timeline for deployment can vary widely based on individuals’ perspectives, vehicle level of autonomy, and anticipated use case. Taking these factors into consideration, a timeline for deployment reflecting anticipated commercial availability was developed with panel and expert input.

While it may not be possible to set a precise date when state motor vehicle codes (MVCs) and regulations will require certain modifications, it is clear that states need to start planning for deployment now. The recommended priorities for modification of laws and regulations have been developed to coincide with this timeline and have been grouped according to the short-term (2018–2020), mid-term (2021–2025), and long-term (2026 and beyond; Figure 1).

This timeline is provided to help state policymakers recognize that the time frame for passenger level 4–5 ADS-equipped vehicles operating in unconstrained environments is likely to be longer, but also that C/ADS-equipped vehicle deployment is unlikely to be linear. What the timeline indicates is that any laws that states need to modify for level 1 truck platooning need to take place immediately. Some states have begun this effort by modifying (as necessary) following distance laws, definitions for platoons, and other impacting constraints. However, states should also recognize that a limited number of level 3 ADS-equipped vehicles are already on the market, with significant market penetration expected by 2020. Additionally, level 4 ADS-equipped A MaaS
shuttles in constrained environments are expected to be in operation in increasing numbers by 2020. SAE J3016 level 1 driving automation system-equipped platooning commercial vehicles are anticipated to be market-ready by 2020 as well. Therefore, laws cannot be modified simply for one level of C/ADS or their expected progression but should be examined holistically with any timeline only as a point of possible reference.

**Overarching Considerations for Prioritization**

As states move forward, the seven overarching considerations presented within this section form the basis for any specific law and regulatory change or priority determination.

1. Assess state objectives.
2. Organize a stakeholder group or advisory committee.
3. Determine the role of stakeholders.
4. Scan the legislative and regulatory landscape.
5. Complete a legal and regulatory inventory audit.
6. Determine the appropriate policy direction regarding federal and state preemption.
7. Identify and educate legislative champions.

These considerations will help states assess their resources and objectives, engage stakeholders, conduct a legal and regulatory inventory analysis (including the prioritization of potential modifications), and evaluate the legal and regulatory modifications. Keeping these considerations in mind will assist states in preparing for and advancing the deployment of level 4–5 ADS-equipped vehicles. Additional discussion regarding these considerations may be found in the section titled Overarching Prioritization Considerations.

**Overarching Legal and Regulatory Modifications**

Stakeholders uniformly noted three areas that must be considered in the short term for law and regulation changes.

1. **Definition Determinations.** This is the first and foundational priority that states should consider, and has been consistently identified as such by stakeholders. The definitions of “driver,” “operator,” “drive,” and “operate” are key first steps. New terms in need of consistent definitions include “autonomous” or “automated” vehicle and a codification of the ADS-equipped vehicle levels based on SAE J3016 definitions.

2. **Platooning Definitions and Associated Allowances.** Stakeholders identified this as the second most important area to consider, as platooning capabilities continue to advance quickly.

3. **Need for Model Definitions and Best Practices.** Lastly, stakeholders noted that a model law may not be the best direction for advancing law and regulation changes. A preferred approach would be developing model definitions that could be used as a basis for states to consider along with best practices language.
C/ADS Legal and Regulatory Prioritization and Harmonization Assessment

Recommendations

The prioritization and harmonization summary tables presented below illustrate that 2018–2020 is an important timeframe for states to begin legislation and regulation changes (Table 1, Table 2, and Table 3). States can choose to make these modifications earlier, but should also closely monitor the marketplace and any federal oversight direction. Just as importantly, any modifications suggested should be in a form that allows for flexible updating and ease of change. Regulations (unless they can be completed rapidly) are most likely not the best choice for modifications. Additional information regarding the prioritization recommendations may be found in Chapters 3 and 5 while additional details regarding the harmonization recommendations are provided in Chapters 4 and 5.

Table 1. Short-Term (2018–2020) Prioritization and Harmonization Modification Summary

<table>
<thead>
<tr>
<th>RECOMMENDATION</th>
<th>HARMONIZATION RECOMMENDED?</th>
<th>CONSUMER C/ADS APPLICATION AFFECTED FIRST</th>
<th>MEANS OF ADDRESSING</th>
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<tbody>
<tr>
<td><strong>DEFINITIONS AND DRIVER ONLY VEHICLE CODES</strong></td>
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<tr>
<td>Conduct a critical review of fundamental vehicle code terms “drive,” “driver,” “operate,” and “operator,” and develop necessary clarification in terms, intent, and interpretation.</td>
<td>Harmonization recommended</td>
<td>C/ADS-equipped passenger vehicles and A-MaaS</td>
<td>Best practice language</td>
</tr>
<tr>
<td>Address the possibility that vehicle codes can be interpreted to regulate only “drivers” (who are licensed and human) and exempt level 4–5 C/ADS-equipped vehicles from legal oversight.</td>
<td>Harmonization recommended</td>
<td>C/ADS-equipped passenger vehicles and A-MaaS</td>
<td>Guidelines (policy decision)</td>
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<tr>
<td><strong>PLATOON-RELATED ISSUES</strong></td>
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<tr>
<td>Consider the need to modify following distance requirements for platoons on a state’s highways. This is particularly important in states that impose prescriptive following distances. Additionally, provide guidance and clarify the legal classification of truck platoons.</td>
<td>Harmonization recommended</td>
<td>Platooning ADS-equipped CMVs</td>
<td>Best practice language; receive guidance (e.g., from the Commercial Vehicle Safety Alliance)</td>
</tr>
<tr>
<td>Develop restrictions as needed if technical scan/engineering analyses identify any negative length, weight, and/or noise effects due to trucks operating as a platoon. Further, audit state laws and regulations that may impose lane restrictions or service requirements on platoons to develop harmonization across the state.</td>
<td>Useful but not essential</td>
<td>Platooning ADS-equipped CMVs</td>
<td>Best practice language; receive guidance (e.g., from the Commercial Vehicle Safety Alliance)</td>
</tr>
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## C/ADS Legal and Regulatory Prioritization and Harmonization Assessment

<table>
<thead>
<tr>
<th>VEHICLE TITLING AND REGISTRATION</th>
<th>Harmonization</th>
<th>C/ADS-equipped passenger vehicles and A-MaaS</th>
<th>Guidelines (policy decision)</th>
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<tbody>
<tr>
<td>Memorialize, from the time of manufacture to junk or salvage on title and registration documents, that the vehicle is driving automation system-equipped. Consider memorialization of aftermarket technologies.</td>
<td>Harmonization recommended</td>
<td>C/ADS-equipped passenger vehicles and A-MaaS</td>
<td>Guidelines (policy decision)</td>
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<table>
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<tr>
<th>PRIVACY PROTECTIONS</th>
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<tr>
<td>Assess state policy protections for privacy-sensitive data collected on vehicles through connected infrastructure and vehicle transmission and also the implications of open records laws and the applicability of current state privacy protection statutes.</td>
<td>No harmonization recommended</td>
<td>Not currently harmonized at the state level; no specific reason to harmonize for C/ADSs.</td>
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<th>USER ATTENTIVENESS</th>
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<tr>
<td>Modify prohibitions against inattentive drivers depending on level of driving automation system deployed.</td>
<td>No harmonization recommended</td>
<td>Not currently harmonized at the state level; no specific reason to harmonize for C/ADSs.</td>
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<tr>
<th>RULES OF THE ROAD – APPLICABILITY TO C/ADS</th>
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<tbody>
<tr>
<td>Identify how and whether the rules of the road apply to different levels of driving automation systems. Ensure that level 4–5 C/ADS-equipped vehicles are not exempted from rules of the road requirements.</td>
<td>No harmonization recommended</td>
<td>Not currently harmonized at the state level; no specific reason to harmonize for C/ADSs.</td>
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<th>RULES OF THE ROAD – LOCAL RESTRICTIONS</th>
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<tr>
<td>Modify local controls over roadways for who can operate on them, the rules of the road, and consider issues of state level preemption.</td>
<td>No harmonization recommended</td>
<td>Not currently harmonized at the state level; no specific reason to harmonize for C/ADSs.</td>
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<th>AFTERMARKET MODIFICATION</th>
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<tr>
<td>Revise or clarify existing laws with respect to whether and how they regulate aftermarket driving automation system-related technologies installed on a vehicle.</td>
<td>Harmonization recommended</td>
<td>C/ADS-equipped passenger vehicles and A-MaaS</td>
<td>Guidelines (policy decision)</td>
</tr>
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<tr>
<th>UNATTENDED VEHICLES</th>
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<tr>
<td>Clarify the meaning of laws that prohibit unattended vehicles, especially for level 4–5 C/ADS-equipped vehicles, including A-MaaS vehicles.</td>
<td>Harmonization recommended</td>
<td>A-MaaS</td>
<td>Best practice language</td>
</tr>
<tr>
<td>RECOMMENDATION</td>
<td>HARMONIZATION RECOMMENDED?</td>
<td>CONSUMER C/ADS APPLICATION AFFECTED FIRST</td>
<td>MEANS OF ADDRESSING</td>
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</tr>
<tr>
<td><strong>DRIVER LICENSING</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Determine who can operate driving automation systems at different levels of driving automation and adjust the law for driver licensing requirements.</td>
<td>Useful but not essential</td>
<td>C/ADS-equipped passenger vehicles and A-MaaS</td>
<td>Reciprocity agreements, best practice language</td>
</tr>
<tr>
<td><strong>DRIVER TESTING AND EDUCATION</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Develop driving tests (or amend existing tests) keyed to varying levels of driving automation systems.</td>
<td>Useful but not essential</td>
<td>C/ADS-equipped passenger vehicles and A-MaaS</td>
<td>Reciprocity agreements, best practice language</td>
</tr>
<tr>
<td><strong>IMPLIED CONSENT</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Consider when “reasonable articulable suspicion” of alcohol or drug use is appropriate in specific operational design domains (ODD) with a properly engaged level 3–5 C/ADS-equipped vehicle.</td>
<td>No harmonization recommended</td>
<td>C/ADS-equipped passenger vehicles and A-MaaS</td>
<td>Assumes definitions are modified to clarify users are considered passengers when traveling in a level 4–5 C/ADS-equipped passenger vehicle or A-MaaS</td>
</tr>
<tr>
<td><strong>PROHIBITIONS AGAINST USE OF ALCOHOL AND LEGAL DRUGS</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Clarify alcohol and drug use and regulation (including in states where marijuana has been legalized) within the various levels of driving automation. Develop offenses, fines, and sentencing terms for lower level violations at varying levels of driving automation.</td>
<td>No harmonization recommended</td>
<td></td>
<td>Not currently harmonized at the state level; no specific reason to harmonize for C/ADS</td>
</tr>
<tr>
<td><strong>MOTOR VEHICLE LIABILITY – USER AND OWNER LIABILITY FOR DAMAGES</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Determine responsibility for crashes, incidents, and harms that may not be the result of human error but rather flaws in the C/ADS as engaged at the time of the event of interest.</td>
<td>Useful but not essential</td>
<td>C/ADS-equipped passenger vehicles (later) and A-MaaS (now)</td>
<td>Best practice language</td>
</tr>
<tr>
<td>RULES OF THE ROAD – DUE CARE STANDARD AND HUMAN JUDGMENT</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>----------------------------------------------------------</td>
<td></td>
<td></td>
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<tr>
<td>Modify or adjust benchmarks to accommodate the decision-making abilities of level 3–5 C/ADS-equipped vehicles operating at level 3 or above, especially for the “due care” standard, which is tethered to human judgment.</td>
<td>No harmonization recommended</td>
<td>Not currently harmonized at the state level; no specific reason to harmonize for C/ADS</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>USER DISTRACTIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Modify anti-distraction provisions to enhance the utility of C/ADS-equipped vehicles for their drivers (while the ADS is unengaged) or passengers (while the ADS is engaged).</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>UNFAIR CRIMINAL AND CIVIL SANCTIONS ON USERS (REASONABLE ARTICULABLE SUSPICION)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amend statutes governing criminal and civil liability to leave open the possibility that when properly engaged, the ADS in a level 3–5 C/ADS-equipped vehicle could also be responsible in whole or in part for a resulting violation.</td>
</tr>
<tr>
<td>Best practice language</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>CRASH REPORTING AND RENDERING AID</th>
</tr>
</thead>
<tbody>
<tr>
<td>Consider the need for modifications to “rendering aid” statutes for level 4–5 C/ADS-equipped vehicles.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>VEHICLE REQUIREMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Consider culling obscure requirements that reference specific items (e.g. use “steering assemblies” rather than “wheels” and “braking systems” rather than “pedals”).</td>
</tr>
<tr>
<td>Reciprocity and/or federal preemption (likely a policy decision)</td>
</tr>
</tbody>
</table>
**Table 3. Long-Term (2026 and beyond) Prioritization and Harmonization Modification Summary**

<table>
<thead>
<tr>
<th>RECOMMENDATION</th>
<th>HARMONIZATION RECOMMENDED?</th>
<th>CONSUMER C/ADS APPLICATION AFFECTED FIRST</th>
<th>MEANS OF ADDRESSING</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>VEHICLE INSPECTION</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Modify agency inspection legislation/regulations to accommodate the new technological features of C/ADS.</td>
<td>No harmonization recommended</td>
<td></td>
<td>Not currently harmonized at the state level; no specific reason to harmonize for C/ADS</td>
</tr>
<tr>
<td><strong>CONSUMER PROTECTION LAWS</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Modify lemon laws to account for new driving automation system-related technologies to ensure adequate consumer protection from product defects.</td>
<td>Useful but not essential</td>
<td></td>
<td>Best practice language</td>
</tr>
<tr>
<td><strong>OCCUPANT SAFETY AND PROTECTION</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Revise occupant safety requirements to take full advantage of driving automation system-equipped vehicles' sensory capabilities (e.g., seatbelts and child boosters).</td>
<td>No harmonization recommended</td>
<td></td>
<td>Not currently harmonized at the state level; no specific reason to harmonize for C/ADS</td>
</tr>
</tbody>
</table>
Chapter 1.

Overview

The fundamental objective of this project is to help states, especially agency leadership in the transportation domain, recognize the critical laws and regulations that may need to be changed or modified as connected and automated driving system (C/ADS)-equipped vehicles are deployed. Industry sectors engaged in C/ADS deployment, legal practitioners, state legislatures, and Governors' offices recognize that current laws and regulations must be addressed in a comprehensive, yet flexible way to ensure safety and reap the anticipated societal benefits of C/ADSs, while at the same time anticipating many unknowns. Unlike traditional legal and regulatory changes or simple citation modifications for adding a new title brand or type of license plate, or instituting an adjustment in fees, fines, or driver sanctions, the changes to C/ADS-related laws are more challenging and require more foundational changes to basic underpinning concepts and definitions, as well as an understanding of the C/ADS technology and its limitations.

Further, there exist a number of situations in which states, through their motor vehicle agency or department of transportation, may find their needs and those of industry best served by synchronizing their efforts in order to harmonize key regulatory or legislative provisions related to C/ADSs. There may also be areas in today’s vehicle codes and regulations where it is important to harmonize for purposes of supporting the deployment of C/ADSs. In this respect, we assess the advantages, disadvantages, and practicality of harmonizing the approaches to these types of laws and regulations across the country.

1.1 Objectives

This analysis set out to 1) identify how and when regulations and laws will need to be modified to facilitate the implementation of C/ADS-equipped vehicles, and 2) identify areas in today's state motor vehicle codes and regulations where harmonization may be important in supporting the deployment of C/ADS-equipped vehicles across the U.S. An understanding of commercial C/ADS application availability and market penetration as well as results from stakeholder outreach efforts and a legal and regulatory review were considered when developing the recommendations regarding potential laws and areas of law that may require modification across different time periods. The following discussion will:

- Delineate the complex interplay between the influence of various vehicle technologies and various vehicle fleets over time and the associated timing for regulatory and legislative reform.
- Identify the regulatory and legal issues related to interoperability.
- Prioritize the progression of laws and regulations based on the short-, mid- and long-term timeframes of C/ADS-equipped vehicles.
- Determine the degree of harmonization that may be possible in the short, mid-, or long-term.
  - Identify the implications for industry if harmonization of state motor vehicle codes and regulations are not achieved.
  - Present the state-perceived barriers to or enablers for advancing harmonization lessons and models of lessons learned.
• The priority charge of this project is to consider existing laws and regulations that may require modification and/or harmonization; the recommended prioritization provided within primarily draws upon findings from an in-depth legal and regulatory review.

1.2 Definitions and Assumptions

The following definitions and assumptions are used to guide the research conducted as part of NCHRP 20-102(07) program activities.

**Levels of Automation**

This project adopts the levels of automation as defined in SAE J3016 (SAE International, 2018). For reference, a summary of these levels is provided in Figure 2.

**The 5 Levels of Driving Automation**

![Image of the 5 Levels of Driving Automation](image)

*Figure 2. SAE J3016 Levels of Automation*

**Definitions of Connected and Automated Driving System (C/ADS) Commercial Applications**

*Connected vehicles* are defined as vehicles equipped for vehicle-to-vehicle (V2V) and vehicle-to-infrastructure (V2I) communications (collectively, V2X) as defined in NHTSA's notice of proposed rulemaking on V2V Communications (Posten & Barrett, 2016) and SAE J2735/J2945 (SAE International, 2016). Connected vehicles allow for low latency direct communications between road entities (e.g., cars, trucks, intersection controllers, pedestrians) to reduce crashes and accomplish other transportation
objectives, while avoiding collection and transmission of personally identifiable information (PII). Traffic agencies can collect traffic flow data from connected vehicles to support their data needs, and traffic agencies can upload data that supports vehicle operations. For instance, Signal Phase and Timing data (available via V2I or “the cloud”) can enable vehicles to anticipate signal timing and adjust speed to reduce delay and conserve fuel. Available data can also be used to support level 4–5 ADS-equipped vehicle control in dynamic situations, such as intersection traversals and work zone configurations.

In this case, we are primarily interested in connected vehicle applications when used in conjunction with driving automation systems at levels 1–2 and level 3–5 ADS-equipped vehicles.

**ADS-equipped vehicles are defined in SAE J3016.** Conditional driving automation is characterized as a level 3 ADS where the sustained and ODD-specific performance of the dynamic driving task (DDT) is completed by the ADS with the assumption that a fallback-ready user is receptive to ADS requests to intervene. Level 3 ADS-equipped vehicles enable the driver to cede full control of all safety-critical functions under certain environmental or traffic conditions, monitor for changes in conditions, and provide the driver with sufficiently comfortable transition time when the ADS senses changing conditions that would make its continued operation unsafe. In level 4–5 ADS-equipped vehicles, the ADS performs the DDT while the user is considered a passenger when the ADS is engaged. Automated mobility as a service (A-MaaS) applications are an example of levels 4–5 ADS-equipped vehicles. Current traffic laws were written with the assumption that a human driver is in control of the vehicle. Vehicles equipped with driving automation systems operating at SAE level 2 and below define the human driver as continuing to perform part of the DDT while the driving automation system (longitudinal and/or lateral vehicle motion control) is engaged. For more information and expanded definitions, see above Figure 2.

**ADS-equipped passenger vehicles.** Those ADS-equipped vehicles purchased or leased solely for personal use, parking, or sending off to park somewhere else when not in use. This use case will require a number of fundamental changes to the vehicle code to permit deployment, but these changes are critical to the eventual deployment of C/ADS because they overcome the many barriers currently posed by the assumption that a human driver will be in control of a vehicle; this underpins most current vehicle codes.

**ADS-equipped commercial motor vehicles (CMVs).** Those ADS-equipped vehicles used for commercial purposes not associated with platooning.

**Platooning.** Platooning is two or more vehicles in line following one another at distances much smaller than human drivers could perform safely. As a result, aerodynamic drag may be decreased, potentially resulting in increased fuel economy. The major interest in platooning is for long-haul trucking. Platooning is enabled by sensor technology and V2V communications. First-generation platooning systems are expected to be level 1, with the ADS controlling the brakes and throttle, and drivers in all vehicles being fully responsible for steering and monitoring the road environment. In the longer term, platooning at higher levels of automation is expected. Platooning is unique in that it requires consideration of following distance in state MVCs. Otherwise, platooning automation aspects would be focused only on level 3 ADS-equipped vehicles and higher, as described above.

**Automated Mobility as a Service, or A-MaaS, can address both passenger and local freight delivery SAE J3016 levels 4–5 ADS-equipped vehicles.** For passengers, A-MaaS is an on-demand, shared, for-hire mobility service offered to the public and utilizing a fleet of level 4 or higher ADS-dedicated vehicle with no expectation that a user will respond to a request to intervene (although the vehicle may be operated by a remote dispatcher). The same applies generally to last mile delivery of freight (parcels); however, the vehicle may be optimized for parcels and not be designed to carry people.
Definition of Harmonization

For purposes of this document, harmonization is defined as the process of minimizing redundant or conflicting standards which may have evolved independently (Pelkmans, 1987). Harmonization can create consistency of laws, regulations, standards, and practices, so that the same rules will apply across jurisdictional boarders. Regulatory harmonization ensures that business rules are followed across borders (Black's Law Dictionary Free Online Legal Dictionary 2nd Ed).

Assumptions

The following assumptions were considered in developing the progressions of priorities needed for the legal and/or regulatory changes outlined in this report. While these assumptions are expected to hold true, regardless of whether they do or not, state policy makers will still need to consider their impact on legal modifications and should consider them in advancing any legislative or regulatory change.

Assumption #1. NHTSA’s Role and Federal Preemption in Key Areas

It is assumed that NHTSA’s delegation of duties and authorities between the federal government and the states will not change. NHTSA notes that under current law, manufacturers bear the responsibility to self-certify that the vehicles they manufacture for use on public roadways comply with the FMVSS. If a vehicle is compliant within this framework and maintains a conventional vehicle design, there is currently no specific federal legal barrier to a C/ADS being offered for sale or for commercial mobility operations. NHTSA’s Best Practices for State Legislatures (See A Vision for Safety 2.0, NHTSA, 2017) confirms that the states retain their traditional responsibilities for driver licensing (perhaps only until the vehicle is “the driver), vehicle licensing and registration, traffic laws and enforcement, and motor vehicle insurance and liability regimes. It is assumed that for harmonization reasons, NHTSA will specifically retain FMVSS settings and manufacturer/technology company vehicle and equipment standards. As the trade association Global Automakers have pointed out, the “primary advantage for federal standards related to the design and performance of motor vehicles is to allow manufacturers to design, build and sell one vehicle across all 50 states” (Global Automakers, 2017). States and their associations need to keep this assumption in mind and remain aware of the changing federal landscape. It is recommended that associations like the AAMVA continue their close coordination with NHTSA and that NHTSA continues to engage AAMVA in assisting the states.

Assumption #2. Commercial Driver’s License Standards and Interstate Motor Carrier Preemption

It is assumed that the FMCSA will promulgate standards in both of these areas. With the importance of harmonization across state lines and the need for one industry standard and state-to-state uniformity, jurisdictional stakeholders clearly indicated that current standards as codified in the Commercial Motor Vehicle Safety Act of 1986 and accompanying regulations for states should be updated by FMCSA in consultation with the states (Commercial Motor Vehicle Safety Act, 1986). States should, however, review their current laws and regulations that codify these federal requirements and consider modifications that would allow for the easy incorporation of new provisions. This is an area of legal review that should not be overlooked. Many state federal codification statutes are specific to a particular law reference or a particular federal regulation. Some even codify the exact wording of the federal regulation. The key in this evolving environment is to review current federal preemptive statutes and consider how they may need to be changed in anticipation of changes at the federal level that govern these statutes.
Assumption #3. Focus on Deployment versus Testing

Further, with the issuance of the Federal Automated Vehicles Policy (NHTSA, 2016) and the subsequent publication, A Vision for Safety 2.0 (NHTSA, 2017), along with the extensive body of current and anticipated laws, regulations, and introduced legislation, the focus of this roadmap document is primarily on driving automation system-equipped and C/ADS-equipped vehicle deployment rather than testing. While this document does highlight legal requirements associated with both the deployment and testing of C/ADS-equipped vehicles, the most likely application of this resource document is deployment efforts. The varied goals associated with testing in states tend to drive testing legislation, so this project would not be as useful to the end users if the focus was primarily on testing.

Assumption #4 Timeline for Deployment

The timeline for deployment can vary widely based on individuals’ perspectives, vehicle level of autonomy, and anticipated use case. Taking these factors into consideration, a timeline for deployment reflecting anticipated commercial availability was developed with panel and expert input.

While it may not be possible to set a precise date when state MVCs and regulations will require certain modifications, it is clear that states need to start planning for deployment now. The recommended priorities for modification of laws and regulations have been developed to coincide with this timeline and have been grouped according to the short-term (2018–2020), mid-term (2021–2025), and long-term (2026 and beyond; Figure 3).

This timeline is provided to help state policymakers recognize that the time frame for passenger level 4–5 ADS-equipped vehicles operating in unconstrained environments is likely to be longer, but also that C/ADS-equipped vehicle deployment is unlikely to be linear. What the timeline indicates is that any laws that states need to modify for level 1 truck platooning need to take place immediately. Some states have begun this effort by modifying (as necessary) following distance laws, definitions for platoons, and other impacting constraints. However, states should also recognize that a limited number of level 3 ADS-equipped vehicles are already on the market, with significant market penetration expected by 2020. Additionally, level 4 ADS-equipped A MaaS shuttles in constrained environments are expected to be in operation in increasing numbers by 2020. SAE J3016 level 1 driving automation system-equipped platooning commercial vehicles are anticipated to be market-ready by 2020 as well. Therefore, laws cannot be modified simply for one level of C/ADS or their
expected progression but should be examined holistically with any timeline only as a point of possible reference.

While states should not overreact to this timeline or any of the other timelines expressed by technology companies, manufacturers, or other private interests, efforts to modify laws should be underway or planned for the immediate and near term. Having the appropriate legislative and legal framework in place, preferably one that permits easy adaptation, will facilitate state efforts to navigate the rapid pace of change and will allow OEMs and technology providers to develop, refine, and apply the technology appropriately, safely, and effectively.
Chapter 2.

Framework for Change

States are currently facing a changing vehicle environment, and there may be incongruities among existing vehicle codes across states. Accordingly, states could benefit from a framework that prioritizes critical legal and regulatory changes. This activity draws on previous efforts to identify and prioritize the likely law and regulation changes that states will need to make. Descriptions of the related preceding activities conducted as part of this NCHRP project are provided below.

2.1 The C/ADS Legal Landscape

Loftus-Otway and Gallun (updated 2018) tracked the innovative legal developments occurring within the U.S. and internationally that seek to facilitate the smooth integration of C/ADSs into existing transportation structures. Readers are encouraged to review the Connected and Automated Systems Legal Landscapes document for considerations of legal and regulatory modifications that states have enacted or considered.1

The types of legislative activity state policy makers recommend and state legislatures enact may be the most pressing priorities for the deployment of level 4–5 C/ADS-equipped vehicles (Figure 4). However, a fair amount of enacted legislation focuses on testing, platooning, and the formation of task forces or study groups to determine next steps. The very suggestion of the need to form a study committee or task force indicates that Governors’ offices, legislatures, agency policy makers, and industry are taking a considered approach to law and regulation change.

Enacted legislation also informs the priorities deemed important, including:

- The formation of working groups and agency task forces,
- A new vehicle designation for level 4–5 ADS-equipped vehicles,
- Clarifying underlying definitions for driver and operator standard terms,
- Platooning impediments and safety assurances,
- Determining licensing requirements, and
- Establishing rules for level 4–5 ADS-equipped vehicles and data usage.

A review of more current legislation (with the exception of some states like California, Nevada, Michigan, Florida and a few others) also reveals that the majority of activity has been focused on testing. For example, in states like California with a greater number of level 4–5 ADS-equipped vehicles, related legislative activity is focused on revising existing and earlier enacted C/ADS statutes and deployment

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1 This document was initially submitted to the NCHRP 20-102(7) panel in January 2017 and was subsequently updated in June and September 2017.
regulations. This legislative landscape is instructive as it provides insight into states’ legal and legislative priorities. It also indicates what state legislatures are not considering, and what barriers may still exist.

While legislation at both the federal and state levels is dynamic, testing and deployment activities demonstrate states’ priorities. Given manufacturers and other private sector lobbying activities regarding federal preemption, Congressional actions also illustrate federal priorities for regulation and industry oversight. On September 6, 2017, the House of Representatives unanimously passed H.R. 3388, the Safely Ensuring Lives Future Deployment and Research in Vehicle Evolution (SELF DRIVE) Act of 2017,[2] by voice vote. This legislation represents a consolidation of 14 individual bills related to C/ADS legislation the House Energy and Commerce Committee's Digital Commerce and Consumer Protection Subcommittee considered. H.R. 3388 (2017) will:

- Advance consumer protections;
- Reaffirm the role and responsibilities of federal and state governments (i.e., designate NHTSA as the lead agency for regulating C/ADSs, pre-empting state rules on matters related to vehicle design, technology performance, cybersecurity, and other areas);
- Update the FMVSS to account for advances in technology and the evolution of level 4–5 ADS-equipped vehicles; and
- Maximize opportunities for research and development.

This Congressional Action, coupled with a cautious process before regulatory actions are undertaken by NHTSA, presents a clear message to the states.[3] States not yet taking regulatory action may benefit from waiting until federal rules providing greater certainty and clearer role designations are in place. For example, NHTSA (2017) suggests that “allowing NHTSA alone to regulate the safety design and performance aspects of ADS technology will help avoid conflicting federal and state laws and regulations that could impede deployment.” However, the drawbacks associated with lengthy and slow legislative processes (e.g., the inability of the regulatory process to keep pace with changing C/ADS technology developments and consumer applications) need to be carefully considered. As such, it is suggested that legislative or regulatory actions be within state purview (consistent with NHTSA's Best Practices for State Legislatures [2017]).

To remain informed about the latest updates in legislative and federal policy debates, state policy makers should continue to engage with national associations and their state chapters. Example organizations include the AAMVA, the American Association AASHTO, the Governors Highway Safety Association, the National Conference of State Legislators, and the National Governors Association (NGA).

Some states have aggressively enacted new legislation to regulate C/ADSs, some have reformed existing laws or regulations, and many others have taken no or minimal action (Loftus-Otway & Gallun, updated 2018). The key topics that states have considered range from platooning to definitions, from study mandates to privacy of data, and from liability to licensing and registration. Many of these areas are identified in Loftus-Otway and Gallun (updated 2018), Serian et al. (2017) and Wagner et al. (2018), and they are highlighted within this report as recommended priorities.

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2.2 Issue Identification and Stakeholder Feedback

To develop a suggested framework for change, jurisdictional and resource stakeholders (described in the following sections) were surveyed via interest-specific online questionnaires and/or guided interviews to determine what recommendations they would suggest to facilitate the testing and deployment of C/ADSs (Serian et al., 2017). Two stakeholder feedback goals were to 1) understand the state motor vehicle code and regulatory reviews underway by states (i.e., jurisdictional stakeholders), and 2) to identify specific laws or areas of law potentially requiring modification as the result of C/ADSs. Another goal was to better understand the prioritization of these areas as well as the anticipated timeline for when modifications should take place. NHTSA’s Model State Policy (included within the Federal Automated Vehicle Policy document; NHTSA, 2016) was used as a guide to focus on those elements delineated for state responsibility.4

As Figure 4 depicts, stakeholders identified modifications to facilitate the deployment of passenger level 3–5 ADS equipped-vehicles as necessary in most areas in less than 5 years. This 5-year timetable is consistent with the deployment timeline guiding this project.

![Projected Timeline for Modifying Laws and/or Regulations to Address Potential Issues Associated with ADS-Equipped Passenger Vehicle Deployment](image)

Figure 4. Jurisdictional and resource stakeholder timeline priorities for levels 3–5 ADS-equipped-passenger vehicle deployment.

The timeframe is important, but the question of what laws and regulations need to change is even more pressing. The priorities for law and regulations changes noted below draw on the findings from the stakeholder outreach effort (Serian et al., 2017).

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4 While these efforts were informed by the Federal Automated Vehicle Policy (2016), the underlying assumptions regarding states’ responsibilities remain the same with the release of NHTSA’s updated automated driving system guidelines, A Vision for Safety (NHTSA, 2017).
Jurisdictional Stakeholders’ Priorities

The jurisdictional stakeholders — stakeholders representing state or provincial departments of motor vehicles (DMVs), departments of transportation (DOTs), and law enforcement agencies — recommend defining the role of the operator/human, addressing interoperability issues, establishing and/or implementing federal regulations/standards (for C/ADSs), and outlining data collection and cybersecurity standards. The following are some examples of stakeholder comments.

- Enable use of level 4–5 ADS-equipped vehicles by defining the role of the human versus the ADS as an operator when the vehicle is in operation. Legal modifications need to begin by moving away from the definition of operator as exclusively human.

- Realize the benefits of connected vehicles by defining the ODD and data requirements.

- Outline who can use automated technology and in what circumstances.

- Address issues related to the transition period when level 4–5 ADS-equipped vehicles and lower level vehicles are in operation together. Address issues related to the transition period when connected and non-connected vehicles are in operation together.

Resource Stakeholders’ Priorities

Resource stakeholders located within and outside the U.S. (i.e., OEMs, suppliers, technology companies, insurance interests, and other interested parties) mentioned several of the issues noted above, including the need for definitions and common core standards for connected and automated vehicles, as well as model laws for data development, retention, and access. Priorities spanned those falling under both federal and state oversight. Following are some examples of these comments:

- Acknowledge and define vehicle connectivity and automation in state motor vehicle codes, and begin making targeted changes to account for automation.

- Increase the cap on FMVSS exemptions per vehicle manufacturer for level 4–5 ADS-equipped vehicles.

- Fully develop and govern the security credential management system for connected vehicles prior to deployment.

- Constrain the use of level 2 driving automation systems to the manufacturer’s intended ODD.

- Work collaboratively to ensure stakeholder buy-in on modifications related to the levels of automation, such as vehicle registration classes and licensing.

- Establish policies to collect data from level 2–5 driving automation system equipped vehicles in a consistent and accessible manner.

- Begin to collect data about driving automation system-equipped vehicles on the road today, and establish mechanisms for pilot projects that will contribute to future policy development.

Additionally, resource stakeholders noted issues with liability and insurance, ownership and licensing, and consumer education and training.
While there were divergent views between public agencies and industry representatives on what the right list of modifications to law should be, there was one common thread throughout all input and current actions: the need for clear and consistent definitions (Figure 5).

![Figure 5. Consistent indication that clear definitions have highest priority.](image)

Resource stakeholders and jurisdictional stakeholders agreed on the timing, with most predicting modifications would be needed within 5 years. They also agreed on the priority of modifications: define the role of the “operator,” ensure common definitions for other key terms, establish and codify federal regulations or common core standards for level 4–5 ADS-equipped vehicles, and address data collection concerns or model laws surrounding data development, retention, and access (Figure 6).

![Figure 6. Commonly identified modifications noted by stakeholders through stakeholder input efforts.](image)

Jurisdictional stakeholders indicated a clear understanding of the need to consider law and regulatory changes, but they also pointed out the tempered and measured pace at which most states are changing laws and regulations, and the depth at which state motor vehicle code and transportation code reviews
occur. The finding that jurisdictions need to begin considering legal and regulatory changes was incorporated as an overarching priority in Wagner et al.’s (2018) in-depth legal and regulatory inventory audit. Accordingly, jurisdictions should complete a legal and regulatory inventory audit of their individual state motor vehicle codes and transportation codes. The final report for this NCHRP project will provide a checklist for this activity.

Through discussions and interviews with stakeholders like AAMVA, it was found that policy makers understand the need for outreach and involvement, especially with regard to transforming initiatives (Serian et al., 2017). Also, as pointed out in recommendations for prioritization in Chapter 5, a considered approach, which recognizes the importance of initial and continued involvement of stakeholders, is an important overarching priority.

2.3 In-Depth Legal and Regulatory Review

The in-depth review of 15 state motor vehicle codes and regulations is the third element used in this approach to prioritizing laws and regulations for modification. While the Loftus-Otway and Gallun's legislative overview and Serian et al.’s stakeholder input activities (updated 2018; 2017) were instructive in showing the landscape and alignment of priorities, Wagner et al. (2018) presents state policymakers with the realities of existing challenges within current laws and regulations and provides a different frame of reference. By examining the text of the statutes themselves, Wagner et al.'s (2018) legal and regulatory review assessed how well existing statutes are likely to hold up under the challenges created by C/ADSs. The Uniform Vehicle Code (UVC) was used in some instances as the base for considered changes, and those citations were supplemented with an appropriate code from the 15 state motor vehicle codes reviewed. States selected for analysis were chosen to represent a range of geographic locations, population densities, and legislative activities. Each of the 15 selected states were categorized into one of three categories based on the extent of activity present: high, low, or minimal to no legislative activity.

- **Category 1 States:** States with high levels of legislative activity. Includes California, Florida, Michigan, Nevada, and Ohio.

- **Category 2 States:** States with low levels of legislative activity. Includes New York, Pennsylvania, Texas, Utah, and Virginia.

- **Category 3 States:** States with minimal to no legislative activity. Includes Mississippi, Nebraska, New Mexico, South Dakota, and Wyoming.

There are many uncertainties regarding C/ADS market penetration, but one thing is apparent: states, and especially state DMVs will be tasked with addressing the uncertainties in law and regulation. Several proactive associations have recognized this reality and have played varying roles in assisting state policy makers. For example, AAMVA has been actively involved in leading efforts related to needed law modifications in an effort to assist their member jurisdictions, emphasize interoperability and reciprocity, and share knowledge and information. Many stakeholders pointed to AAMVA as the lead association in assisting states in advancing model laws or best practices and noted that the organization plays a key role now and will continue to do so in the future (Serian et al., 2017). AAMVA has recognized the importance of having a continued role in the development of state model definitions or best practices and also acting as a facilitator to advance state-to-state interoperability and reciprocity (AAMVA Autonomous Vehicle Best Practices Working Group, personal communication, August 9, 2017).
Chapter 3.

Overarching Prioritization Considerations

The findings from previous activities suggest the need for states to get as "centric" as possible to the intersecting realities of technological imperatives, public policy, and stakeholder interests. The point where these realities intersect represent opportunities for legal and regulatory modifications (Figure 7).

![Image]

Figure 7. Visual depiction of the centric approach to prioritization efforts.

Ideally, state legislative and regulatory schemes would fit neatly within the intersection of these circles. However, the reality of adapting legislation and regulation for C/ADSs will likely be messier, straying in one direction or another on a given issue or at a particular moment in time.

When assessing law and regulation change, the closer a legislative and regulatory approach comes to the theoretical center where technology, stakeholders, and current laws, regulations, and policies meet, the more likely that change is to meet public policy objectives, avoid or withstand external challenges, and meet the needs of a complex, evolving technology.

As states move forward, the seven overarching considerations presented within this section form the basis for any specific law and regulatory change or priority determination. These considerations will help states assess state resources and objectives, engage stakeholders, conduct a legal and regulatory inventory analysis (including the prioritization of potential modifications), and evaluate legal and regulatory modifications. Keeping these considerations in mind will help states remain centric as they advance and prepare for the deployment of level 4–5 ADS-equipped vehicles.

3.1 Consideration 1: Assess State Objectives

States should determine their goals and objectives for C/ADS deployment. For example, a state’s focus may be research-based, economic development-based, or safety-based. The desire for modifications may be driven from internal or external (e.g., industry driven change) forces. States may move modifications forward to advance certain deployments quickly or they may take a more holistic approach and plan for the deployment of all C/ADSs.

It is critical that a state determine its own goals from a multi-agency approach. States should:

- Clearly outline the state’s and leaderships’ expected roles in modifying laws and regulations.
C/ADS Legal and Regulatory Prioritization and Harmonization Assessment

- Understand the key drivers.
- Ensure a strategic approach.
- Determine who will lead the effort.
- Set the strategic course from a state perspective, ensuring the incorporation of a state motor vehicle code perspective as well as a broader transportation perspective.
- Create a policy framework.

We can look to Utah, Virginia, and Pennsylvania for good examples of embracing the overarching priority of determining state goals and objectives. For example, Virginia recently developed its vision for advancing C/ADSs in the state: “To create a strategic policy framework for transitioning autonomous vehicles into the Virginia transportation network, and associated Autonomous Vehicle program, by which the Office of the Secretary can position Virginia to be a national leader in the rapidly advancing field of self-driving, connected mobility” (Day, 2017). Pennsylvania also recently outlined its C/ADS statewide strategic plan, calling for expanding existing research, using actionable information and developing near-term and long-term actions in nine areas ranging from driver licensing and motor vehicles to workforce requirements (Myers, 2017).

The Utah DOT (2016) outlined key policy considerations or strategic questions that needed to be addressed for the state to determine this foundational priority consideration. The report noted the following among a number of questions policymakers may consider:

- Is Utah’s goal to be an early adopter of level 4–5 ADS-equipped vehicles? If so, what are the legislative priorities associated with enabling that goal? Does any existing legislation hinder this goal?
- Does Utah wish to make a greater effort to leverage autonomous vehicle technology growth for potential economic development? If so, which sectors of the industry and/or which manufacturers are the best fit for Utah? How can Utah incentivize private industry to locate and invest here?
- Should Utah take a more conservative approach of learning from national efforts and other states before moving forward on new legislation, policies, or efforts to entice private industry partnerships?

3.2 Consideration 2: Organize a Stakeholder Group or Advisory Committee

Many states have begun the outreach process and a number of states are using advisory or working groups or steering committees (referred to more generally as stakeholder groups), recognizing that this is an important step to engage cross-agency representation, industry and other interest groups. In forming these groups, states should consider:

- Obtaining broad-based input from industry and appropriate state and federal agencies, including DMVs, DOTs, law enforcement, NHTSA and the FHWA, OEMs and suppliers, technology companies, insurance interests, and others that are state appropriate.
- Including inside counsel (or external if appropriate).
Consulting with the Attorney General's Office to develop a more systematic and coordinated approach to legal challenges.

Engaging with the Governor’s office and staffs as well as state legislative representatives (e.g., to assess the current political climate, to identify potential legislative champions and opportunities to include key members of the legislature and their staffs).

Legislative action may be needed in some states to develop advisory groups or steering committees; this type of mandate is often a state’s initial C/ADS-related legislation. Some examples of recent legislative action include the following:

**Wisconsin.** Executive Order 245 (2017) created the Governor’s Steering Committee on Autonomous and Connected Vehicle Testing and Deployment. The Committee is charged with identifying all agencies in the state with jurisdiction over testing and deployment of the vehicles, coordinating with the agencies to address concerns related to issues such as “vehicle registration, licensing, insurance, traffic regulations, equipment standards, and vehicle owner or operator responsibilities and liabilities under current law,” and reviewing current state laws and regulations that may impede testing and deployment, along with other tasks.

**Connecticut.** CT Public Act No. 17-69 (June 27, 2017) establishes a task force to study “fully autonomous vehicles,” to evaluate the standards established by NHTSA regarding state responsibilities for regulating fully autonomous vehicles, the laws, legislation and regulations proposed or enacted by other states, and recommendations on how the state should regulate.

**Vermont.** Act No. 38 (HB 494) (May 17, 2017) requires the DOT to convene a meeting of stakeholders with expertise on a range of topics related to “automated vehicles” and to report any recommendations, including proposed legislation, to the legislature.

Stakeholder committee charters should clearly note the timeframe for the committee's activities, the committee's charge (e.g., complete an audit, provide opportunities for information sharing), and anticipated deliverables (e.g., a prioritized list of modifications), if any.

### 3.3 Consideration 3: Scan the Legislative and Regulatory Landscape

Loftus-Otway and Gallun (updated 2018) provides an overview of the types of legislative actions that have taken place in the past years. This information is instructive and provides states with templates to consider. Especially relevant are the definitions states are considering for level 4–5 ADS-equipped vehicles, level 1 and 2 driving automation system platooning technologies, and C/ADS operators and manufacturers. A sampling of activity is included here to demonstrate the divergent measures that are quickly becoming law. These activities are important and progressive, but are equally concerning in that they have led to inconsistent laws and definitions across states. It is becoming clearer and more urgent, based on the varying definitions that are emerging in state laws, that codified federal guidance is needed soon and/or that associations like AAMVA or AASHTO quickly develop guiding documents that specifically address aspects of the law such as definitions. Again, development of consistent definitions is paramount in the short-term. Some examples of various definitions are included in Table 4.
**Table 4. Definition-Related Legislative Examples**

<table>
<thead>
<tr>
<th>State/Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>California</strong></td>
<td></td>
</tr>
<tr>
<td>CA Veh Code § 38750 (through 2013 Leg Sess)</td>
<td></td>
</tr>
<tr>
<td>Operator (of an autonomous vehicle)</td>
<td>The person who is seated in the driver’s seat, or if there is no person in the driver’s seat, causes the autonomous technology to engage.</td>
</tr>
<tr>
<td>Manufacturer (of an autonomous vehicle)</td>
<td>The person that originally manufactures a vehicle and equips autonomous technology on an originally completed vehicle or, in the case of a vehicle not originally equipped with autonomous technology by the manufacturer, the person that modifies the vehicle by installing autonomous technology to convert it to an autonomous vehicle after the vehicle was originally manufactured.</td>
</tr>
<tr>
<td><strong>Arkansas</strong></td>
<td></td>
</tr>
<tr>
<td>Arkansas Code § 27-51-305</td>
<td></td>
</tr>
<tr>
<td>Driver-assistive truck platooning system</td>
<td>(2)(d) Technology that integrates sensor array, wireless communication, vehicle controls, and specialized software to synchronize acceleration and braking between two (2) or more vehicles while leaving each vehicle’s steering control and systems monitoring and intervention control of its human operator.</td>
</tr>
<tr>
<td><strong>Nevada</strong></td>
<td></td>
</tr>
<tr>
<td>NRS 484A.080</td>
<td></td>
</tr>
<tr>
<td>Driver</td>
<td>Sec. 11.5.(2) If a vehicle is an autonomous vehicle, as defined in NRS 482A.030, and the automated driving system, as defined in NRS 482A.025, of the autonomous vehicle is engaged, “driver” means a person who causes the automated driving system of the autonomous vehicle to engage.</td>
</tr>
<tr>
<td>Autonomous vehicle network company</td>
<td>Section 14.24 : An entity that, for compensation, connects a passenger to a fully autonomous vehicle to provide transportation services or transports goods using a fully autonomous vehicle. Note: this task refers</td>
</tr>
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<table>
<thead>
<tr>
<th>State/Term</th>
<th>Definition</th>
</tr>
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<tbody>
<tr>
<td>to TNCs in the automated environment as Automated Mobility as a Service or A-MaaS</td>
<td></td>
</tr>
<tr>
<td>Texas</td>
<td></td>
</tr>
<tr>
<td>Chapter 545, Sec. 545.451.</td>
<td></td>
</tr>
<tr>
<td>Automated driving system</td>
<td>Hardware and software that, when installed on a motor vehicle and engaged, are collectively capable of performing the driving task without any intervention or supervision by a human operator. This includes all aspects of the entire DDT for the vehicle on a sustained basis and fallback maneuvers necessary to respond to a failure of the system.</td>
</tr>
<tr>
<td>Automated motor vehicle</td>
<td>A motor vehicle on which an automated driving system is installed.</td>
</tr>
<tr>
<td>Entire dynamic driving task</td>
<td>the operational aspects (steering, braking, accelerating, and monitoring the vehicle and the roadway) and tactical aspects (responding to events, determining when to change lanes, turning, using signals, and other related actions) of operating a vehicle. However, it does not include strategic aspects, including determining destinations or waypoints.</td>
</tr>
<tr>
<td>Human operator</td>
<td>A natural person in an automated motor vehicle who controls the entire DDT and “Owner” has the meaning assigned by current statute (AN ACT relating to automated motor vehicles, 2017)</td>
</tr>
<tr>
<td>Louisiana</td>
<td></td>
</tr>
<tr>
<td>Section 1. R.S. 32:1(1.2)</td>
<td></td>
</tr>
<tr>
<td>Autonomous technology</td>
<td>Technology installed on a motor vehicle that has the capability to drive the vehicle on which the technology is installed in high- or full-automation mode, without any supervision by a human operator, with specific driving mode performance by the automated driving system of all aspects of the DDT that can be managed by a human driver, including the ability to automatically bring the motor vehicle into a minimal-risk condition in the event of a critical vehicle or system failure, or other emergency event</td>
</tr>
</tbody>
</table>
These are just a few examples of recent state legislative activity. In scanning the state landscape, state policy makers should take full advantage of these considerations and lead such associations as AAMVA, from a state motor vehicle code and law enforcement perspective, and AASHTO, through their work on the connected vehicle and infrastructure perspective, to assist states in an understanding and awareness of the landscape.

3.4 Consideration 4: Complete a Legal and Regulatory Inventory Audit and Determine the Best Route for Codification and Modification of Laws and Regulations

This project’s legal and regulatory review provided a checklist of areas where key laws and regulations may need to be modified. (That checklist is provided in this document at Table 5). State legal professionals and advisory committees can use this checklist as an initial guide for conducting a legal and regulatory inventory audit. Based on the knowledge gained from past efforts, an audit should focus on state motor vehicle codes first. Other portions of state laws, particularly transportation, can be added later. It is also our recommendation that this **audit**—supported by a committee—should be completed in the near-term, ideally within 6 months. This audit should also review accompanying regulations as they interface with C/ADS-equipped vehicle deployment and suggested law changes. The results of this audit should form the basis for a master plan that will guide and inform all future legal action and interaction with state legislatures. The audit should not only identify laws and regulations that need to be changed and new programs that should be added, but should also consider which institution is best prepared to make these changes and the extent of citizen outreach that is necessary.

Findings from the stakeholder outreach effort revealed that very few states have undertaken a detailed legal and regulatory inventory audit. Most states’ approaches to C/ADSs are more “casual” in nature and not detailed to specific areas of law. One of the key reasons for this is because most states are in C/ADS testing mode. However, due to the federal government’s automated driving systems policy (NHTSA, 2016; updated 2017), which focuses on testing, states are expected to begin addressing deployment regulations. A legal audit is the first step in addressing any needed changes in or additions to these regulations.

Based on our review of state efforts, stakeholder input, the legal and regulatory inventory audit findings, and past experience in this area, the following should be considered when conducting a legal and regulatory inventory audit:

- State motor vehicle agencies should take the lead. They are best equipped to understand implications to current vehicle and driver laws and also best suited to understand the implications to harmonization and state-to-state reciprocity. Other agencies should be involved as deemed necessary.

- While some states continue to contemplate the advancement of level 4–5 ADS-equipped vehicles, the focus tends to be only on testing. A comprehensive focus on laws and regulations should cover not just testing but also deployment and the various models for deployment along with their specific and unique challenges.

- It is unlikely that state legislatures will grant state agencies the unilateral authority to make regulation modifications without oversight once legal structure is in place for level 4–5 ADS-equipped vehicles, but states should consider requesting a more flexible approach to needed changes as technology evolves. One state in our study considered codifying basic level 4–5 ADS-equipped vehicle legislation and permitting the DMV to issue policy to address fast moving
changes, but the state's Legislature has yet to agree to this approach. One possible alternative is to legislate yearly formal updates and grant the DMV authority to issue and enforce policy until any changes can be modified in law.

- As revealed through the legal and regulatory inventory audit and assessment (Wagner et al., 2018), there are fundamental laws that will require modification (as prioritized later in this Assessment). State policy makers should use this document as a guide to their legal review.5

The level 4–5 ADS-equipped vehicle landscape is a non-traditional landscape that requires a non-traditional response from state legislatures. DMVs will need laws with flexibility that create an entirely different paradigm, which may require state legislatures to let go of some of the more operational DMV oversight. In some states, regulations can take 12–24 months to modify or enact. As such, this avenue of change is not recommended, unless a state determines that rulemaking is a more expedient and flexible route to enacting change than through legislative action. The most flexible and expedient route, with ample opportunity for public and stakeholder input, should be determined by the state.

North Carolina’s approach to C/ADS rules and regulations is worth noting here on two fronts:

- The extensive legal audit they did of their state motor vehicle code (Kimley-Horn, 2016).

North Carolina chose to add a completely new article to its general statutes covering definitions, the regulation of level 4–5 ADS-equipped vehicles (including driver’s licensing requirements, vehicle registration, unattended vehicles, and the application of FMVSS local preemption), the creation of an ongoing Fully Autonomous Vehicle Committee, and other areas. While some stakeholders consulted did not recommend adding completely new sections to legislation, it is a consideration for states and may prove to be more expedient and flexible. Most jurisdictional stakeholders, however, noted that adding completely new sections to legislation, like North Carolina did, would be difficult, as current vehicle codes are too complex and laden with existing, interrelated case law to start from scratch.

As part of North Carolina's C/AV Roadmap Development Project, a review of North Carolina's General Statutes Chapter 20 (Motor Vehicles) and Chapter 58 (Insurance) was performed. The ensuing report provided a summary table that included the relevant page number within the chapter, article and section number, section title, levels of automation where the comments should be considered, and the suggested focus of the discussion. The recommendations were developed to guide the appropriate working groups with a starting point for analysis. Their approach included comments on elements of the statutes possibly requiring revision(s) in response to the advancement of ADS technologies (Kimley-Horn, 2016).

California took a legislative approach similar to North Carolina’s by adding specific C/ADS laws and regulations and updating them as changes in the market occurred. Further, Pennsylvania recently considered amending the current vehicle code by adding a new chapter for level 3–5 ADS-equipped vehicles with cross-references to existing code (AN ACT Amending Title 75 [Vehicles] of the Pennsylvania Consolidated Statutes, 2017).

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5 Wagner et al. (2018) also present a systematic method for reviewing state legal and regulatory requirements that readers of this report may find useful.
No matter what the approach, a state motor vehicle code audit is an important overarching priority consideration. To assist with this process, it is important to continue to monitor activities from the federal government as well as the ongoing work of associations (such as AAMVA from a state motor vehicle code and law enforcement perspective and AASHTO from a C/ADS and infrastructure perspective).

3.5 Consideration 5: Determine Appropriate Policy Direction Regarding Federal Preemption and Local Restrictions.

While both NHTSA and its counterparts at FMCSA have issued C/ADS policy guidance, neither has yet issued any regulatory provisions. This lack of definitive guidance for both testing and deployment, along with efforts in Congress surrounding federal preemption, make it murky at best for states to make decisions regarding federal preemption. Nonetheless, based on stakeholder input and current federal preemption surrounding motor carrier and commercial driving, it is recommended that decisions regarding the role federal preemption will play in modification of state motor vehicle codes be made early on. It is likely that vehicle standards will continue to be a federal role (i.e., the FMVSS), due to their importance for seamless nationwide C/ADS deployment. States should also consider what role they believe, as a matter of policy, federal definitions will play as state laws are modified and leave placeholders for these future laws. For example, states now codify in legislation the Commercial Motor Vehicle Safety Act of 1986. It is, however, necessary for states to use less specific language in the C/ADS area. This is especially true until federal guidance is more than just guidance.

Similarly, strategic consideration should be given to what role local restrictions will be permitted or required to have regarding level 4–5 ADS-equipped vehicle deployment. This is especially relevant for A-MaaS deployment and the most recent introduction of ride share services. State and local preemption provisions are an important factor as states consider this overarching priority. When local ordinances and regulations are layered into level 4–5 ADS-equipped vehicle deployment law and regulation modifications, the situation becomes complex, especially for OEMs and technology companies. These types of strategic considerations need to be made early in the audit process, as do incorporated statute modification provisions for any statutes governing federal or local preemption. Examples of recent state efforts include the following:

**Colorado:** Colorado SB 17-213 (June 1, 2017) declares the regulation of ADSs a matter of statewide concern, and, therefore, local authorities are prohibited from regulating these systems. The use of ADSs is authorized if the system is capable of conforming to every state and federal law applying to driving. If not, a person testing a system is required to coordinate with the Colorado state patrol and the Colorado DOT.

**Tennessee:** Tennessee SB 0598 (May 6, 2015) prohibits local governments from banning the use of C/ADS technology

**Texas:** Texas SB 2205 (June 15, 2017) regulates the operation of "automated motor vehicles" and "automated driving systems." The act precludes political subdivisions or state agencies from imposing a franchise or other regulation related to the operation of a C/ADS.

Legislation such as that discussed above is important, as it employs a holistic perspective that includes all types of C/ADSs. Many issues, such as lane access and parking, which have traditionally been the jurisdiction of local governments will be important in the deployment of C/ADSs and related law modifications, particularly for A-MaaS deployments.

With this in mind, it is important to:
• Include, as part of a state’s determination of its goals and objectives for C/ADSs, and as part of its legal audit, discussions with any advisory or steering committee on federal and state preemption. This is an important overarching priority for motor vehicle law modification considerations and a state’s legislative strategy.

• Continue to monitor activities at the federal level, especially the efforts of Congress and any updates to NHTSA’s policy to consider federal preemption.

3.6 Consideration 6. Determine the Role of Stakeholders

The appropriate role of manufacturers, technology companies, and other interests should be determined. Most stakeholders consulted for this project recognized the new roles that technology companies, manufacturers, dealers, A-MaaS providers, and fleet operators may play as C/ADSs are deployed (Serian et al., 2017). These interest groups, and the coalitions they have formed, are very much engaged in the federal direction of C/ADS regulation and are also engaged in current state stakeholder efforts. Areas such as product liability, consumer education, data privacy, and cyber security are all key stakeholder interests. States should determine the role for private interests based on their state’s objectives for deployment. In this regard, state stakeholders have noted that there must be transparency from these interest groups. A tendency to overstate technology capabilities, for instance, does not serve the best interests of states when determining needed law or regulation priorities.

Future Congressional action (and federal preemption) may limit the need for involvement from stakeholders regarding vehicle performance, testing, vehicle standards, and other non-traditional state roles, but nonetheless, collaboration and/or coordination with OEMs and suppliers will be important based on what may be new roles for manufacturers and their dealers. The same applies to technology companies who are not traditional dealers. Figure 8 shows the percentage of stakeholders responding to questionnaires who recognized the need for significant new vehicle manufacturer and dealer responsibilities (Serian et al., 2017).

![Figure 8. Stakeholders’ perceived need for significant new vehicle manufacturer and dealer responsibilities.](image)

3.7 Consideration 7: Identify and Educate Legislative Champions

State legislators, especially those in leadership roles in transportation and those involved in the stakeholder group, must be engaged in deliberations and state considerations for law and regulation modifications. Stakeholders responding to the questionnaire (Serian et al., 2017) also pointed out a current lack of legislative understanding, underscoring the need for states to begin legislative discussions in the short term. Such discussions should include C/ADS educational components to help legislators...
understand necessary law and regulation modifications and the need to find ways to allow for continual and accelerated revisions based on technology changes. A subsequent activity for this NCHRP project will provide states with a guidance document on engaging the Legislature.

### 3.8 Overarching Legal and Regulatory Modifications

Stakeholders uniformly noted that there are three areas that must be considered in the short term for law and regulation changes (Serian et al., 2017).

1. **Definition Determinations.** This is the first and foundational priority that states should consider, and has been consistently identified as such by stakeholders. The definitions of “driver,” “operator,” “drive,” and “operate” are key first steps. New terms in need of consistent definitions include “autonomous” or “automated” vehicle and a codification of the ADS-equipped vehicle levels based on SAE J3016 definitions.

2. **Platooning Definitions and Associated Allowances.** Stakeholders identified this as the second most important area to consider, as platooning capabilities continue to advance quickly.

3. **Need for Model Definitions and Best Practices Language.** Lastly, stakeholders noted that a model law may not be the best direction for advancing law and regulation changes. A preferred approach would be developing model definitions that could be used as a basis for states to consider along with best practices language.

A detailed discussion for additional legal and regulatory modifications to be considered in the short-, mid-, and long-terms is provided in the following chapter.
Chapter 4.

Framing the Issues for Harmonization

4.1 Overarching Considerations Regarding Harmonization

Individual state laws and regulations for C/ADS are vital, but equally important is ensuring that vehicles can operate seamlessly across state lines. Ensuring state laws do not substantially conflict can occur through harmonization, which is the process of minimizing redundant or conflicting standards that may have evolved independently (Pelkmans, 1987). Harmonization can create consistency of laws, regulations, standards, and practices, so that the same rules will apply across jurisdictional boarders. Harmonization is agnostic to the specific policy approach, and can mean moving all jurisdictions’ standards to the strictest standard, most permissive standard, a midpoint between the two poles, or to a more uniform standard.

Harmonized state regulations for C/ADSs offer a number of critical advantages over a diverse and discordant set of state regulations. However, while harmonization has some advantages, there are some drawbacks, possible alternative strategies, and several areas that do not need harmonization for the safe deployment and operation of C/ADSs. The following subsections explore harmonization of motor vehicle codes and other rules governing C/ADSs, considering benefits, drawbacks, examples, and alternatives to harmonization.

Potential Benefits Associated with Harmonization

As with most regulatory discussions revolving around C/ADSs, the primary rationale for harmonizing state motor vehicle codes is to make vehicles and roadways safer for all users, improve enforcement, and increase driver awareness. Furthermore, the potential for substantial reductions in motor vehicle crashes, fatalities, and injuries serves as the driving force behind the generally supportive posture the public sector has taken towards C/ADSs (Strickland, 2013). At the same time, states are motivated to remove any barriers to the operation of safe C/ADSs to encourage private sector investment and research into this technology. Consistent, clear, and predictable rules across disparate political entities can reduce complexity for manufacturing and product development, potentially reducing costs to industry and consumers alike. Harmonization therefore touches issues that affect state policy makers and agencies, industry, and the traveling public alike.

The business case for C/ADSs depends, in part, on state harmonization of motor vehicle codes. To the degree that similar regulations are in place across many or all states (for example, liability), some introductions of C/ADS technologies may be accelerated, increasing the market size. A-MaaS use cases, for example, rely on a “network effect” to function effectively (Rogers, 2016). Services like A-MaaS must build out a robust network of users to function, and states with consistent rules make it easier for companies to build a user base across state lines.

The business case for C/ADSs in CMV operations can also depend on harmonized state motor vehicle codes and regulations. For example, many goods reach markets via CMVs, and ensuring their safe and efficient operation is important for other road users, the companies receiving and shipping the goods, and the users of the goods. Harmonized state motor vehicle codes can reduce the regulatory burden on CMV operators transporting goods across state lines, and may also be relevant as platooning CMVs enter the transportation network. From a broader economic perspective, harmonization offers a seamless regime that facilitates the free flow of goods and commerce across borders without regulatory barriers.
When there are disparate approaches to regulating specific aspects of vehicle equipment, manufacturing costs may rise (Canis and Lattanzio, 2014). Harmonization at the state and local levels can reduce these costs, which in turn is likely to benefit consumers through lower product prices and a more efficient technology rollout. This efficiency stems from the regulatory consistency that is provided for manufacturers of vehicles, as well as system developers regarding uniform vehicle functionality, external markings, and several other areas that could help reduce development and implementation complexity and accelerate market introductions.

Another motivation for harmonization is facilitating data sharing between states, such as improving interstate consistency for vehicle records designations (e.g., titling). Note that harmonization of areas such as liability and insurance requirements may need to be approached based on the type of consumer ADS application. Within this analysis, harmonization considerations are presented in terms of consumer ADS applications (C/ADS-equipped passenger vehicles and A-MaaS; see Chapter 1 for definitions) explored throughout the stakeholder feedback activities (Serian et al., 2017).

**Potential Drawbacks of Harmonization**

While harmonization offers many advantages for states, industry, and the traveling public, there are also downsides that bear consideration. Perhaps the most obvious concern a state might have regarding harmonization is a loss of control over policy decisions. Under the Tenth Amendment to the Constitution, states maintain powers not designated to the federal government (U.S. Const. amend. X).

Harmonization can reduce complexity by aligning a disparate set of rules or regulations. However, doing so can also cause problems if the harmonized rules are inappropriate, premature, or have other flaws. If an industry or product is not technically mature, for example, establishing rules prematurely could hamper innovation by restricting the product or industry in ways that may not improve safety or efficiency. If states harmonized to a premature or inappropriate set of rules, the problematic rule would shift from being a local or regional problem to being a national problem. For this reason, those involved in the harmonization process should carefully consider the costs and benefits to all stakeholders and interests, including manufacturers and the traveling public, both with regards to safety and cost.

Beyond overt disadvantages, there are also basic questions of necessity when considering harmonization across all states. Harmonization is not a simple or speedy process, and typically takes several years to complete. Due to the slowness and difficulty of harmonizing regulations, states may wish to avoid harmonization for areas that are neither necessary nor beneficial.

For issues that do not expressly need state harmonization, each state could ensure their laws and/or regulations are clear, in particular as they relate to core terms and definitions (e.g., drive, driver, operate). Additionally, states could require that all vehicles follow the rules of the road, regardless of whether a human driver or the ADS performs the DDT. However, flexibility in interpretation and execution of the rules of the road is also important, in that rules enable vehicles—both ADS and human-operated—to make reasonable decisions in a complex and dynamic operating environment.

Harmonization may also be unnecessary when regulating certain aspects of C/ADS, as some manufacturers may develop the ability to automatically adjust to new parameters and requirements whenever crossing state lines or any jurisdictional boundaries. As an example, A-MaaS operations areas may gradually expand as regulatory regimes evolve. In much the same way that C/ADSs will need to adjust automatically to each roadway’s speed limit, developers could potentially include automatic adjustments for other non-hardware related regulatory provisions.
Some stakeholders were very pessimistic about the likelihood of harmonization occurring (Serian et al., 2017). They noted that states fundamentally work at different paces, so there will be regulatory differences despite states’ best efforts. Further, even though there are examples of successful harmonization (e.g., the Manual on Uniform Traffic Control Devices [MUTCD]), in many stakeholders’ minds, there is “no mechanism for national harmonization.” Without such a mechanism, harmonization will likely prove challenging. Furthermore, each state has its own unique formation of regulatory agencies, particularly with regard to the jurisdiction of for-hire vehicles and A-MaaS services. In California, Pennsylvania, and a number of other states, Public Utilities Commissions regulate for-hire vehicles at the state level. Meanwhile, in states like New York, local-level governmental entities regulate taxis and for-hire livery vehicles, like the New York City Taxi and Limousine Commission. These commissions do not use motor vehicle codes to create regulations, and instead, implement any regulations or policies they choose unless states preempt local rules (National League of Cities, 2017, p. 12; Moran, 2017).

In some cases, industry standards could be the best source for a regulation’s required technical details; however, this is highly situationally specific. Further, it should be noted that industry standards typically take several years to complete, although the creation of industry standards is generally faster than developing new federal regulations. Historically, industry standards development organizations have served the role of addressing design specifics without direct government involvement. As an example, SAE developed a taxonomy for ADSs (see Figure 2) that helps industry, government, and other stakeholders understand and converse about different levels of vehicle automation (SAE, 2018). Industry and stakeholders worked together to develop these definitions, and formal state or federal regulations were unnecessary.

There are several topic areas addressed in this study, such as registration, which are relevant to but do not have technical impacts upon ADSs and have not historically required state harmonization. In these cases, we recommend against harmonization simply due to new factors added by ADS capabilities.

Additionally, broad harmonization may not make sense in situations where the applicability of particular use cases is low for certain states or regions. For instance, states without significant urban areas would be unlikely to prioritize A-MaaS for modifications to their driving codes. These jurisdictions are more likely to adopt changes similar to larger states if markets for these use cases eventually become relevant.

Lastly, in the event of federal pre-emption of ADS equipment and operation aspects, harmonization is achieved through invoking federal authority. This is discussed further below.

**Upward Versus Downward Harmonization**

As noted earlier, the simple act of harmonization should not be the end goal for states. There is a critical difference between upward and downward harmonization. In upward harmonization, states with less stringent regulatory regimes harmonize with states with more stringent requirements. In downward harmonization, the equilibrium for agreed upon standards is driven to the lowest common denominator by the states with the most lenient regulations and requirements.

Recent experience in the U.S. demonstrates the potential for downward harmonization. States briefly suspended regulatory efforts in 2015 after several years of various states passing C/ADS testing regulations. The pause in laws occurred when the industry responded to new C/ADS testing regulations by moving their testing and development work out of states with testing laws, such as California and Florida, to states without testing regulations that did not require testing companies to register or seek permission prior to conducting public testing. As such, upward harmonization toward stricter standards solely for the sake of stricter standards should not necessarily be viewed as the states’ objective. The potential risk of downward harmonization, however, toward simply achieving the lowest common
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denominator, is likely to produce a regulatory regime that serves industry’s, rather than the traveling public’s, interests. As harmonization activities proceed, these factors must be carefully weighed.

**Implications of Not Harmonizing**

Much of the above discussion has centered on the benefits that come from states harmonizing their vehicle codes and standards for C/ADS, but it is equally important to note the risks for industry and the broader public if such harmonization, where needed, does not occur. Without harmonization, industry faces what has been termed a “patchwork quilt” of state regulations.

The risk associated with the failure to harmonize standards when needed is that industry testing and eventual deployment of C/ADS will be unnecessarily delayed and/or potentially not broadly available, the safety benefits of C/ADSs will be lost, and the lives saved from roadway fatalities will be lessened. Regulatory inconsistencies will create roadblocks for C/ADS testing and operation if the differences include conflicting standards or excessive overlapping of state, county, regional, and local requirements.

This risk is associated only with a failure to harmonize those areas we have recommended for harmonization. For areas identified as not requiring harmonization, the impact on industry is deemed much less detrimental with regard to testing, development, and deployment of C/ADSs. This is a result of the current lack of harmonization in these areas across states. We believe industry can comply with any existing related provisions without impacting their timelines for C/ADS deployment or the manufacturing process.

For hardware, design, and other fixed vehicle attributes, harmonization through federal preemption is likely necessary. Standards that address or prohibit allowable hardware, hardware mounting, or other hardware aspects essential to level 4–5 ADS-equipped vehicles could prove prohibitive to their interstate operation, thus conceivably blocking market introduction.

### 4.2 Alternatives to Harmonization

**Reciprocity Agreements**

Harmonization is not the sole mechanism for achieving seamless authority to operate a motor vehicle across state borders with different laws, regulations, standards, and practices. Reciprocity agreements represent a highly effective, and frequently utilized, alternative in which states sign agreements to mutually recognize each other’s licenses, share driver infraction records, or any other provision of vehicle codes that are necessary for operating vehicles in other states.

Three examples of existing interstate compacts include 1) The Driver License Agreement, 2) the Driver License Compact, and 3) the Non-Resident Violator Compact (AAMVA, n.d.; National Center for Interstate Compacts, n.d.a; National Center for Interstate Compacts, n.d.b). Under these arrangements, states agree to mutually honor licenses issued by other states, share information regarding out-of-state infractions and driver safety, and allow for the processing of traffic citations across state borders. Most states take part in these arrangements: 44 out of 50 (88%) participate in the Non-Resident Violator Compact, and 45 of 50 (90%) participate in the Driver License Agreement, for example. These agreements ease interstate travel without the harmonization of state vehicle codes or licensing requirements. The process for a state to join a reciprocity agreement or interstate compact such as these can involve state legislatures ratifying the agreement and the passage of legislation to codify the content of the reciprocity agreement. This process can be lengthy, and historically, some states have taken years to sign these compacts. An example candidate for reciprocity could include permit requirements for platooning level 1 driving automation system-equipped vehicles. However, with the recognition of the obstacles to interstate compact agreements, this is not a preferred recommended direction.
Model Law / Best Practice Language

Another approach that can make the harmonization process much easier is drafting model legislation or best practice language. A model law is a complete piece of legislation, pre-made and ready for introduction into the legislative process. Best practice language is less formal, and features pre-crafted tenets or aspects of legislation that lawmakers can adopt into law. This approach is effective because it enables unfamiliar legislators to start from a prepared text rather than requiring each individual state, and each legislative committee within each state, to craft original language. In discussions with state administrators, we found that stakeholders view model legislation as a solid foundation for state laws and cross-jurisdictional reciprocity (Serian et al., 2017). Similarly, state DOTs echoed the importance of uniform regulatory efforts related to infrastructure improvements, such as interconnected traffic signals and other V2I systems for connected vehicles.

Model laws or best practice language can be useful to technologically-naïve lawmakers, who do not have the time to become experts in the intricacies of the technology or its full array of policy implications. However, while model laws can be helpful, they are far from perfect, as there are rarely issues as complex as those surrounding C/ADSs that can be addressed within the text of a singular, universal bill. Additionally, variation among existing state codes can make it difficult to apply model laws, as doing so would require closely scrutinizing existing code and replacing it with model language. States, working with the legislatures, can then utilize the model language within the content of a bill, drafted according to their state’s statutes, codes, and regulatory agency structures. Associations such as AAMVA and AASHTO and the Uniform Law Commission are important resources and ideally should (with their members’ guidance and involvement) drive model law considerations. History teaches a lesson here as well. Model laws are difficult to get legislatively enacted in some states.

The legislative process is complicated. Bills often change substantially from introduction to acceptance, which can reduce the effectiveness of model legislation. For these reasons, based on our interviews, many industry representatives favor the less prescriptive best practice language approach over that of model law when seeking harmonization; this is a lesson they learned through experience during past attempts to enact model bills across the states (Serian et al., 2017).

Guidelines

Lastly, states should consider the use of less prescriptive and more flexible guidelines at the state level. NHTSA used this mechanism with the issuance of non-binding Federal Automated Vehicle Guidelines in 2013, again in 2016, and further updated under the current DOT leadership (NHTSA 2013, 2016, 2017).

Based on our stakeholder feedback, recent experiences in the C/ADS regulatory area have led many to believe that it is likely too hard to “go straight to regulations” and that an approach centered on the issuance of clear guidelines may prove to be better. When responding to questionnaires, several stakeholders, including manufacturers and technology companies, cited the State of California’s in-depth regulations for the testing and deployment of C/ADSs as a reason for moving their testing operations to other, less demanding state regulatory regimes, such as Texas and Arizona (Serian et al., 2017), which are following a more hands-off approach that places fewer restrictions on C/ADS testing on public roadways.

Guidelines addressing key areas of needed legal changes, such as definitions, developed at the federal level with input from state- and local-level government entities and other stakeholders (e.g., national and state associations, citizen groups) can provide state policy makers with a starting point for their individual efforts. Further, guidelines may serve as a catalyst for harmonization across states.
4.3 Consumer C/ADS Application Harmonization Considerations

Just as there are varying levels of urgency for the recommended modifications and reviews that states should take to remove barriers to the operation of C/ADS-equipped vehicles on the roads, the same tiered urgency applies to the question of whether or when states should harmonize their vehicle codes to provide consistent standards across state borders. The importance of and need for harmonization is also often determined by the path to deployment of the various consumer C/ADS applications.

C/ADS-Equipped Passenger Vehicle Harmonization Needs

Harmonized regulations applying to personal C/ADSs will be essential to the long-term development of automated mobility. Some of these will be addressed via efforts to enable A-MaaS in the 2020 timeframe, with broad availability of personal C/ADSs coming shortly thereafter. In fact, initial personal level 3 ADS-equipped vehicles are now entering the European market. The European model year 2018 Audi A8, for example, offers a level 3 ADS traffic jam assist function (Davies, 2018).

Platooning C/ADS-Equipped CMV Harmonization Needs

Unlike personal C/ADSs and A-MaaS, truck platooning may require changes to state motor vehicle codes, and truck platooning will eventually evolve from first generation SAE level 1 driving automation systems (with full driver involvement in steering and monitoring the road environment) to level 4 follower ADS-equipped vehicles. This harmonization analysis focuses on level 1 platooning where there are relatively few areas affecting initial deployment, but the areas that do exist are essential to opening the way for this important safety and energy conservation application. The primary area is creating appropriate following distance rules for automated longitudinal control rather than human control of brakes and throttle.

A-MaaS Harmonization Needs

A-MaaS involves the use of level 4 or 5 ADS-equipped vehicles offered for commercial transportation on-demand. This will function similarly to today’s transportation network companies, such as Uber and Lyft, but without drivers. Several unique aspects of this service model will require additional modifications to state motor vehicle codes.

For A-MaaS, aspects of inspection and vehicle maintenance will fall to the fleet operator, which may choose to adopt very high maintenance standards for purposes of quality control and ensuring high customer service levels. States will need to take care to avoid a situation where low quality A-MaaS services are able to shop around to find the state with the fewest inspection requirements and then operate their entire fleets under that state’s flag. At the same time, many major cities that are likely to be the primary focus for A-MaaS operations are part of larger, multi-state metropolitan areas, such as the New York City and New Jersey/Connecticut area or Washington, DC and its Maryland and Virginia suburbs. A-MaaS vehicles will need to operate seamlessly across such borders, even when not carrying passengers or safety drivers.

6 Consistent with North American Council for Freight Efficiency's Confidence Report: Two-Truck Platooning (NACFE; 2017), this harmonization analysis focuses on "near-term two-truck platooning opportunities where human drivers have their hands on the wheel and the technology is assisting the driver in getting better fuel economy by reducing aerodynamic drag through safely following another vehicle at shorter distances than an unassisted driver could maintain" (p. 3).
4.4 Examples of Past Harmonization Efforts

Commercial Driver Licensing

Harmonization has already occurred among the states for facilitating interstate transportation in commercial driver licensing policies for the motor carrier industry. FMCSA has worked closely with the states through AAMVA to improve licensing, testing, and training requirements for commercial drivers to ensure the highest level of safety on the roadways through harmonized standards. Harmonization efforts in this area have also focused on the free sharing of information through the Commercial Driver's License Information System (CDLIS),7 and the National Driver Registry to account for interstate activities and safety infractions (FMCSA, 2014).

FMCSA establishes the minimum standards that states must meet when creating the processes for receiving a commercial driver’s license (CDL) or a commercial learner’s permit (FMCSA, 2017). However, the actual administration of their CDL program, along with the issuance of the CDL itself, is primarily the responsibility of states. Furthermore, states may choose the specific design for their own application process, set the rate for license fees, determine their own license renewal procedures, perform inspection checks, and determine reinstatement requirements for drivers after a disqualification. The only caveat being that the federal standards and criteria must be met, although the FMCSA does issue exemptions, which the states must follow.

Meanwhile, states may augment the driver’s licensing process with their own knowledge and skills tests; however, these tests must meet minimum federal standards8. To assist in the development of these tests, model driver and examiner manuals and tests have been prepared and distributed to the states to use, if they wish.

As outlined in Serian et al. (2017), state stakeholders clearly indicated that, to accommodate changes due to C/ADS, current standards as codified in the Commercial Driver Safety Act and accompanying regulations for states should be updated by FMCSA in consultation with the states. States, however, should review their current laws and regulations that codify these federal requirements and consider modifications that would allow for easier incorporation of new provisions.

4.5 Federal Preemption

The impetus behind federal preemption has historically been to avoid a patchwork of state standards and regulations. The federal government has strongly indicated it will address standards for C/ADS hardware and software such that state level regulations (or harmonization) will not be necessary, and that federal laws and standards could preempt state policy (NHTSA, 2016, 2017). Under this scenario, the harmonization of certain aspects of C/ADS regulations and standards would become moot as NHTSA (or FMCSA for motor carriers) would set standards, preventing states from enacting standards that differ from federal rules. Enforcement of federal standards would largely depend on the specifics of the policy in question; currently, many automotive safety and environmental regulations are enforced via self-certification, and this seems a likely avenue for future enforcement mechanisms (Canis and Lattanzio, 2014). As noted in the previous chapter, with the unanimous passage of the SELF DRIVE Act of 2017 by the House of Representatives,

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7 The CDLIS was established under the Commercial Motor Vehicle Safety Act (CMVSA) of 1986 and is based on the Federal Motor Carrier Safety Regulations (FMCSR) in 49 CFR 383 and 384.
8 As outlined in Subpart G and H of 49 CFR Part 383.
Congress has already begun to consider preemption of state and local regulations and laws pertaining to hardware and design features for C/ADSs.
Prioritization and Harmonization

Recommendations

States should examine the fundamental legal concepts and terms that undergird their motor vehicle and transportation programs and consider how these concepts and terms will be affected by the use of C/ADSs. This is a time to assess and then act, rather than reacting or acting just for the sake of action. These latter approaches result in the crafting of piecemeal revisions and solutions to legal impediments and gaps as they arise, but fail to recognize the more strategic implications of specific law changes that go deeper than one piece of a state motor vehicle code. During the assessment process, states are advised to refer to NHTSA's guidance (2017) which encourages states "to allow DOT alone to regulate the safety design and performance aspects of ADS technology. If a State does pursue ADS performance-related regulations, the State should consult with NHTSA" (2017, p. 20). NHTSA notes that "allowing NHTSA alone to regulate the safety design and performance aspects of ADS technology will help avoid conflicting federal and state laws and regulations that could impede deployment" (2017, p.18).

The legal review revealed 23 specific legal and regulatory modifications (Table 5; Wagner et al., 2018). Throughout this chapter, those modifications have been prioritized based on past experience, input from stakeholders (Serian et al., 2017), and the anticipated timeline of level 4–5 ADS-equipped vehicle deployment (Figure 4). All changes to laws and regulation should be girded by the state’s goals and objectives surrounding level 4–5 ADS-equipped vehicle deployment and an individual state motor vehicle code assessment.

Within each prioritization timeframe, harmonization recommendations, if any, are discussed in terms of potentially-affected C/ADS applications (C/ADS-equipped passenger vehicles, platooning driving automation system-equipped CMVs, and A-MaaS; see Chapter 1 for definitions), which were explored throughout the issue identification and stakeholder feedback activities (Serian et al., 2017). In some cases, harmonization may be useful in reducing potential barriers or accelerating deployment, but is not essential for deployment. In those cases, we note that harmonization is useful (versus recommended). We also call attention to areas of law where there could be significant value in addressing the issues within individual states; these areas are not currently harmonized at the state level, and there is no specific reason to do so for C/ADSs.

Table 5. Critical Category Checklist for State Legal Audits

<table>
<thead>
<tr>
<th>Checklist of State Code Provisions Potentially Needing Modification or Clarification</th>
<th>Recommendation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Conduct a critical review of fundamental vehicle code terms “drive,” “driver,” “operate,” and “operator,” and develop necessary clarification in terms, intent, and interpretation.</td>
</tr>
<tr>
<td>2</td>
<td>Address the possibility that vehicle codes can be interpreted to regulate only “drivers” (who are licensed and human) and exempt level 4–5 C/ADS-equipped vehicles from legal oversight.</td>
</tr>
<tr>
<td>3</td>
<td>Determine who can operate driving automation systems at different levels of driving automation and adjust the law for driver licensing requirements.</td>
</tr>
</tbody>
</table>
## Checklist of State Code Provisions Potentially Needing Modification or Clarification

<table>
<thead>
<tr>
<th>Recommendation</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>Develop driving tests (or amend existing tests) key to varying levels of driving automation systems.</td>
</tr>
<tr>
<td>5</td>
<td>Modify prohibitions against inattentive drivers depending on level of driving automation system deployed.</td>
</tr>
<tr>
<td>6</td>
<td>Clarify the meaning of laws that prohibit unattended vehicles, especially for level 4–5 C/ADS-equipped vehicles, including automated mobility as a service (A-MaaS) vehicles.</td>
</tr>
<tr>
<td>7</td>
<td>Amend statutes governing criminal and civil liability to leave open the possibility that when properly engaged, the ADS in a level 3–5 C/ADS-equipped vehicle could also be responsible in whole or in part for a resulting violation.</td>
</tr>
<tr>
<td>8</td>
<td>Consider when “reasonable suspicion” of alcohol or drug use is appropriate in specific ODD with a properly engaged level 3–5 C/ADS-equipped vehicle.</td>
</tr>
<tr>
<td>9</td>
<td>Clarify alcohol and drug use and regulation (including in states where marijuana has been legalized) within the various levels of driving automation. Develop offenses, fines, and sentencing terms for lower level violations at varying levels of driving automation.</td>
</tr>
<tr>
<td>10</td>
<td>Modify anti-distraction provisions to enhance the utility of C/ADS-equipped vehicles for their drivers (while the ADS is unengaged) or passengers (while the ADS is engaged).</td>
</tr>
<tr>
<td>11</td>
<td>Memorialize, from the time of manufacture to junk or salvage on title and registration documents, that the vehicle is driving automation system-equipped. Consider memorialization of aftermarket technologies.</td>
</tr>
<tr>
<td>12</td>
<td>Consider culling obscure requirements that reference specific items (e.g., use “steering assemblies” rather than “wheels” and “braking systems” rather than “pedals”).</td>
</tr>
<tr>
<td>13</td>
<td>Modify agency inspection legislation/regulations to accommodate the new technological features of C/ADSs.</td>
</tr>
<tr>
<td>14</td>
<td>Revise or clarify existing laws with respect to whether and how they regulate aftermarket driving automation system-related technologies installed on a vehicle.</td>
</tr>
<tr>
<td>15</td>
<td>Determine responsibility for crashes, incidents, and harms that may not be the result of human error but rather flaws in the ADS as engaged at the time of the event of interest.</td>
</tr>
<tr>
<td>16</td>
<td>Modify lemon laws to account for new driving automation system-related technologies to ensure adequate consumer protection from product defects.</td>
</tr>
<tr>
<td>17</td>
<td>Identify how and whether the rules of the road apply to different levels of driving automation systems. Ensure that level 4–5 CADS-equipped vehicles are not exempted from rules of the road requirements.</td>
</tr>
<tr>
<td>18</td>
<td>Modify or adjust benchmarks to accommodate the decision-making abilities of level 3–5 CADS-equipped vehicles operating at level 3 or above, especially for the “due care” standard, which is tethered to human judgment.</td>
</tr>
<tr>
<td>19</td>
<td>Modify local controls over roadways for who can operate on them, the rules of the road, and consider issues of state level preemption.</td>
</tr>
<tr>
<td>20</td>
<td>Revise occupant safety requirements to take full advantage of driving automation system-equipped vehicles’ sensory capabilities (e.g., seatbelts and child boosters). Consider the need for modifications to “rendering aid” statutes for level 4 and 5 C/ADS-equipped vehicles.</td>
</tr>
</tbody>
</table>
| 21             | Platooning related recommendations:  
  a. Consider the need to modify following distance requirements for platoons on a state’s highways. This is particularly important in states that impose prescriptive following distances.  
  b. Provide guidance and clarify the legal classification of truck platoons. |

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5.1 Short-Term (2018–2020) Modification Priorities and Harmonization Recommendations

With many OEMs and new entrants in the manufacturing sector pointing to the range of 2018–2020 as their target dates for C/ADS deployment, states will need to begin to build the legal and regulatory framework for level 4–5 ADS-equipped vehicles.

Nearly half of the 23 modifications identified should begin now in the short-term (2018–2020). Priorities in this short-term are described for states in terms of what needs to be done, the reasoning and related concerns behind the recommendations and specific accompanying recommendations for modification.

**Short-Term Recommendation 1: User Requirements Definitions and Driver Only Vehicle Codes**

States, if they have not yet done so, should review the fundamental terms “drive,” “driver,” “operate,” and “operator,” as well as any wording that arguably omits any restrictions on C/ADS-equipped vehicles. Any ambiguous terms should be clarified to provide consistency and reduce ambiguity. Additionally, policy makers should directly address the possibility that their vehicle codes can be interpreted to regulate only “drivers” (who are licensed and hence human), thus potentially exempting from legal oversight level 4–5 C/ADS-equipped dedicated vehicles (ADS-DVs) where the ADS is the “driver.”

**Prioritization Reasoning**

When code terms are ambiguous, they should be accompanied by the clarification of intent and interpretation to provide consistency and clarity. This will also allow DMVs, DOTs and law enforcement agencies that interact with level 4–5 C/ADS-equipped vehicles, whether through licensing and regulation, provision of infrastructure, or law enforcement, interpretive guidance to assist in developing new programs.

The need for uniform or best practice definitions from both a state and federal perspective cannot be overemphasized. Law enforcement, motor vehicle administrators and technology companies all recognize the need for uniform or closely uniform definitions, particularly as they relate to the terms “driver and operator” and “drive and operate” (Figure 9). The need for codified definitions pertaining to SAE 3016 vehicle levels was also clearly echoed by DMVs and law enforcement agencies.
While many states also have begun to develop definitions for different types and levels of C/ADS-equipped vehicles, this is an area that is clearly in need of consistent definitions, best practice definitions, or federal intervention. Although many states are using NHTSA's Federal Automated Vehicle Policy (2016) and subsequent *A Vision for Safety 2.0* (2017), there are a number of instances in which states have developed their own definitions. In the past year alone, a wide range of varying state definitions have been legislated. As these examples show, while many of the definitions are similar, they are not sufficiently consistent (Table 6), and represent a clear threat to harmonization, state-to-state reciprocity, longer term vehicle titling and identification issues, manufacturer and technology company design and sales concerns, as well as A-MaaS launch and deployment.

Moving forward, states should be mindful of a current NHTSA project—Assessment, Evaluation, and Approaches to Technical Translations of FMVSS and Test Procedures That May Impact Compliance of Innovative New Vehicle Designs Associated with Automated Driving Systems—which is considering these definitional issues as well as issues associated with vehicle requirements.

### Table 6. Examples of Varying Definitions of Autonomous Technologies and Vehicles

<table>
<thead>
<tr>
<th>State/Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Autonomous technology</td>
<td>Technology which is installed on a motor vehicle and which has the capability to drive the motor vehicle without the active control or monitoring of a human operator. The term does not include an active safety system or a system for driver assistance, including, without limitation, a system to provide electronic blind spot detection, crash avoidance, emergency braking, parking assistance, adaptive cruise control, lane keeping assistance, lane departure warning, or traffic jam and queuing assistance, unless any such system, alone or in combination with any other system,</td>
</tr>
</tbody>
</table>
enables the vehicle on which the system is installed to be driven without the active control or monitoring of a human operator

| Michigan |
| MI Comp L § 257.2b, 2016 |
| Automated technology | Technology installed on a motor vehicle that has the capability to assist, make decisions for, or replace an operator. |
| Automated motor vehicle | A motor vehicle on which automated technology has been installed, either by a manufacturer of automated technology or an upfitter that enables the motor vehicle to be operated without any control or monitoring by a human operator. Automated motor vehicle does not include a motor vehicle enabled with 1 or more active safety systems or operator assistance systems, including, but not limited to, a system to provide electronic blind spot assistance, crash avoidance, emergency braking, parking assistance, adaptive cruise control, lane-keeping assistance, lane departure warning, or traffic jam and queuing assistance, unless 1 or more of these technologies alone or in combination with other systems enable the vehicle on which the technology is installed to operate without any control or monitoring by an operator |

| Tennessee |
| Autonomous technology | Technology "that has the capability to drive [a] motor vehicle without the active physical control or monitoring by a human operator." |
**Harmonization Reasoning**

The terminology currently used in most state motor vehicle codes was recorded during a time when C/ADSs, or any computer-enhanced operations of a motor vehicle for that matter, were unheard of and technologically infeasible. If harmonization of state motor vehicle codes does not occur before other legal modifications, states may create conflicting, overlapping, and misaligned terminology and definitions for common terms that will make national standards even more difficult to construct. As noted above, conflicting definitions are beginning to emerge. Uniform definitions or best practices terminology, developed by either NHTSA or AAMVA, would greatly benefit the harmonization of these definitions across these fundamental aspects of the driving code.

**Harmonization for A-MaaS**

The impact of outdated and/or conflicting definitions on A-MaaS applications should be a focus for harmonization, as the A-MaaS business model is dependent on states harmonizing a number of changes to their vehicle codes. This harmonization is anticipated to take place from 2018–2020, likely before C/ADS-equipped passenger vehicle applications reach the market. A-MaaS allows companies to spread out the higher cost of purchasing a C/ADS-equipped vehicle across many users and to collect data to inform development and improvements in future systems. The harmonization recommendations noted above in terms of definitional clarifications apply strongly to A-MaaS as well. The growth of the A-MaaS market depends on clarifying that A-MaaS customers are passengers (as opposed to drivers) and have no responsibility for the safe or lawful operation of the ADS-equipped vehicle in which they are riding.
Prioritization and Harmonization Recommendations

**Prioritization Recommendation:** In developing laws, regulations, and policies, ensure that the included definitions, especially those for level 3–5 C/ADS-equipped vehicles, are consistent with the SAE framework (as reflected in NHTSA, 2017).

**Harmonization Recommended:** Yes. Best practices language

**Consumer C/ADS application(s) affected first:** C/ADS-equipped passenger vehicles and A-MaaS

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**Prioritization Recommendation:** States should consider working with NHTSA and AAMVA to develop uniform definitions for the terms “driver,” “operate,” and “operator” as best practices or uniform definitions. This effort should recognize the possibility that state vehicle codes can be interpreted to regulate only “drivers” (who are licensed and hence human) and thus effectively exempting from legal oversight level 4–5 C/ADS-equipped vehicles (where the C/ADS, when engaged, could be considered the “driver”).

**Harmonization Recommended:** Yes. Guidelines (policy decision)

**Consumer C/ADS application(s) affected first:** C/ADS-equipped passenger vehicles and A-MaaS

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**Short-Term Recommendation 2: Platooning-Related Code Provisions**

Policy makers should audit their highway/transportation state laws and regulations to identify those areas that deter the use of platoons. Areas possibly requiring modification include lane restrictions, service requirements, size, weight, and following distance—following distance being a frequently addressed area (Serian et al., 2017). Policy makers should also determine if local governments will have the ability to regulate platoons in ways that differ from the rest of the state. A number of stakeholders noted the need to address state regulations related to move over laws, following distance and tailgating, passing of other vehicles, convoys, and vehicle size and weight laws. However, some stakeholders saw no need for any legal or regulatory changes. As highlighted in Wagner et al. (2018), perspectives vary based on how jurisdictions interpret their current law and regulation wording. As with operator and driver definitions, some states have begun to define what a platoon is, where it can operate, and how approvals will be considered.

**Prioritization Reasoning**

Most states within our sample impose following distance requirements that are incompatible with the deployment of truck platoons. If platoons are to be encouraged on a state’s highways, modification of these following distance requirements will likely be necessary. Within state DMVs and DOTs, platoons are generally treated as groups of individual trucks, sometimes operating as a caravan. However, within the language of existing state codes, other terms theoretically could be interpreted to cover platoons. To take one example, in the UVC and many states codes, there is a repeated reference to a “combination of vehicles,” a term that is almost never defined. While there appears to be strong consensus that the term
does not cover platoons, the law itself is somewhat ambiguous on this point. Indeed, because of this ambiguity, one state (Michigan) clarified in 2016 language that a platoon is not considered a “combination of vehicles” [See MI § 643a(10)]. A clearer definition of platoon will then help pave the way for other needed legal adjustments to the regulation of platoons.

Since trucks in platoons operate independently but in relative close proximity, state regulators may need to consider the aggregate length, weight, and possible noise restrictions as they apply to a set of trucks operating as a platoon, depending on the outcome of relevant engineering analyses. Consideration for modifications should also address lane restrictions (if needed) or service requirements on platoons from a harmonization perspective. Platoons are likely to operate across state boundaries and travel over both state and local roadways, emphasizing the need for consistency in definitions from state to state. Truck platooning (especially platooning with level 1 or level 2 driving automation system-equipped CMVs) seems to have fewer legislative barriers than other level 4–5 C/ADS-equipped vehicles. Some examples identified in Loftus-Otway and Gallun (updated 2018) include the following.

**Florida.** Florida following-distance and passing traffic laws had to be legally clarified (CS/CS/HB 7061: Transportation, 2016). Florida HB 7061 amended s. 316.003, F.S. to define “driver-assistive truck platooning” as “vehicle automation and safety technology that integrates sensor array, wireless communications, vehicle controls, and specialized software to synchronize acceleration and braking between up to two truck tractor-semitrailer combinations, while leaving each vehicle’s steering control systems command in the control of the vehicle’s driver” (CS/HB 7061: House of Representatives Staff Analysis, 2016). Florida, by amending s. 316.303, F.S., also authorized active displays on screen while the vehicle is in motion.9 The bill’s language exempts level 4–5 ADS-equipped vehicles or vehicles with driver-assistive truck platooning technology from a prohibition against television-type receiving equipment being visible from the driver’s seat.

**Texas.** HB 1791, which took immediate effect, regulates the use of connected braking systems to maintain distance between vehicles (An Act Relating to the Use of Connected Braking Systems to Maintain Distance Between Vehicles, 2017). Section 545.062 of the Transportation Code is amended by adding Subsection (d), which states, “An operator of a vehicle equipped with a connected braking system that is following another vehicle equipped with that system may be assisted by the system to maintain an assured clear distance or sufficient space as required by this section.” “Connected braking system” is defined as “a system by which the braking of one vehicle is electronically coordinated with the braking system of a following vehicle.” As with SB 2205, discussed in the definition section above, this act provides no rule making powers to any transportation or public safety agency in the state.

Not all jurisdictional stakeholders believed that following-distance laws and/or regulations in their jurisdiction would be affected by commercial platooning. However, others indicated that their rules would be greatly affected, and, in some cases, had already required modification (Serian et al., 2017; Figure 10).

With regard to prioritization, resource and jurisdictional stakeholders indicated the need to address platooning-related laws in less than 5 years (Serian et al., 2017). Platooning is one of the deployments that is expected to advance sooner than other C/ADS deployments, which is another reason for states to consider holistic approaches to law changes from the beginning of any rule and regulation modification process.

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9 FLA. HB 7061, as Fla.Stat. 316.303, “unless the vehicle is equipped with the autonomous technology, as defined in s. 16.003(2), and is being operated in autonomous mode, as provided in s. 316.85(2).”
Harmonization Reasoning

Platooning Driving Automation System-Equipped CMVs

Truck platooning is in need of short-term harmonization to amend state vehicle codes to remove unintentional barriers to deployment of platooning level 1 or level 2 driving automation system equipped CMVs. The interstate nature of commercial motor carriers demands uniformity (to the degree possible) among state vehicle codes related to platooning. As such, this represents a call for states to work together to harmonize their updated regulations to permit the use of this technology seamlessly across state lines.

Currently, state laws regarding truck following distances are a patchwork of numeric minimums at various distances and language such as “safe and prudent” following distances that require interpretation as to the legality of platooning. Given that platooning is expected to be commercially available in the near future, consistent treatment of platooning to create a nationwide regime that recognizes a mode of longitudinal control dependent on sensing and connected braking to maintain safe shorter distances is valuable in the short term (North American Council for Freight Efficiency, 2016). At the same time, tech developers have noted their systems will have the ability to automatically adjust to new parameters and requirements whenever crossing state lines or any jurisdictional boundaries.

As previously noted, the legal classification of a platoon is generally not specified in state codes. The provision of additional guidance or amended laws to provide a clearer definition of the classification of truck platoons is important to avoid confusion and lend regulatory certainty to technology developers and the trucking industry.
Consideration of Aggregate Length, Weight, and Noise Limits as well as Lane Restrictions for Platoons

Now is the time to conduct the necessary analyses to determine if there are any negative length, weight, and/or noise effects due to heavy CMVs operating as a platoon. Any requirements stemming from these analyses would ideally be harmonized from the start. However, if any restrictions are levied on truck platoons with regard to length (number of tractor-trailer combinations in the platoon), weight, or noise, embedded software systems may be able to adjust operations as needed when crossing state lines (e.g., through the use of embedded mapping software and protocols). Or, in the case of specific bridges identified by a state as vulnerable to a platoon traversal, software could dissolve the platoon temporarily prior to crossing the bridge. Therefore, lack of harmonization with regard to operational restrictions on platoons should not delay the early growth of platooning deployment; however, deployment of platooning will grow more robustly if these factors are harmonized (again, if engineering analyses actually determine there are factors to be addressed). It could be argued then, that individual early-deployment states could take the lead in working out best practices, with harmonization coming in the 2020 timeframe.

Prioritization and Harmonization Recommendations

**Prioritization Recommendation:** If platoons are to be encouraged on a state’s highways, modification of following distance requirements will likely be necessary, particularly in states that impose prescriptive following distances.

**Prioritization Recommendation:** The legal classification of platoon is generally not specified in state codes. Policy makers should consider providing guidance or amend laws to provide a clearer definition of the classification of truck platoons.

**Harmonization Recommended:** Yes. Definitions surrounding platooning could benefit from best practices definitions and consistency from state to state. States should consider working with AAMVA, AASHTO, the Commercial Vehicle Safety Alliance, and FMCSA, to develop consistent platooning recommendations.

**Consumer C/ADS application(s) affected first:** Truck platooning ADS-equipped CMVs

**Prioritization Recommendation:** Since trucks in platoons operate independently but in relative close proximity, state regulators may—if supported by engineering analyses—need to consider the aggregate length, weight, and possible noise restrictions as they apply to a set of trucks operating as a platoon.

**Prioritization Recommendation:** In addition to a vehicle code review, policy makers should audit their highway/transportation state laws and regulations to identify those that impede the benefits of platoons. Some areas possibly requiring modification include lane restrictions, service requirements, size and weight, and following distance, which has been addressed frequently with regard to driving automation systems. In addition, policy makers need to determine if local governments will have the ability to regulate platoons in ways that differ from the rest of the...
Another important consideration for policy makers is harmonization across local boundaries, state boundaries, and international boundaries so as to not impede commerce.

**Harmonization Recommended**: Useful, but not essential. Definitions surrounding platooning could benefit from best practices definitions and consistency from state to state. States should consider working with AAMVA, AASHTO, the Commercial Vehicle Safety Alliance, and FMCSA, to develop consistent platooning recommendations.

**Consumer C/ADS application(s) affected first**: Truck platooning ADS-equipped CMVs

### Short-Term Recommendation 3: Vehicle Identification and Title Brands

This recommendation addresses two areas highlighted by stakeholders and revealed in Wagner et al. (2018): 1) how a vehicle will be identified as a level 4–5 ADS-equipped vehicle (an OEM and NHTSA role), and 2) how vehicles may need to be branded or identified for titling and/or registration. Each state currently has varying title brands and inconsistent definitions for brands. This is an area that should be considered in the short-term to allow states moving forward at the onset of C/ADS development to adopt consistent title and registration branding.

#### Prioritization Reasoning

As the term denotes, “brands” determine the designation of the SAE J3016 automation level associated with a driving automation system-equipped vehicle, and are associated with the vehicle identification number. These brands follow the vehicle from birth (manufacturing) to death (salvage or destruction). State law enforcement personnel stakeholders specifically noted that vehicle identification markings are a top priority and should be nationally uniform. The ability to access vehicle records electronically at roadside makes the presence of branding on a registration card somewhat unnecessary. However, there was strong concurrence from resource and jurisdictional stakeholders that titles (ownership documents) should be branded with an ADS code. Further, it was recommended that a uniform title brand be suggested by NHTSA for use across all states (Figure 11; Serian, et al., 2017).

#### Harmonization Reasoning

Each state currently has varying title brands and inconsistent definitions for brands. This is an area that should be considered in the short-term to allow states moving forward at the onset of C/ADS development to adopt consistent title and registration branding.

#### Prioritization and Harmonization Recommendations

- **Prioritization Recommendation**: States should consider modifying statutes that define vehicle brands based on SAE J3016 automation level, and include new title brands for level 3 and higher
ADS-equipped vehicles. State accommodations for title brands should follow the SAE levels, but also make provisions for aftermarket applications and brand revisions.

Harmonization Recommended: Yes. Guidelines (policy decision)

Consumer C/ADS application(s) affected first: C/ADS-equipped passenger vehicles and A-MaaS

**Short-Term Recommendation 4: Data Privacy and Data Security**

While NHTSA and other federal regulators are deeply engaged in the various privacy issues presented by connected vehicles, which may also be automated, states should also consider statute changes to ensure public confidence and clarity on data collection and use. Two key legal issues should be addressed in this short-term timeframe. State policy makers should ensure that if privacy-sensitive data is collected on vehicles through connected infrastructure or otherwise, that data is not publicly accessible—for example through Open Records Statutes—in ways that can compromise the privacy of individual drivers, riders or passengers (e.g., by being linked to specific cars or rides). Second, states should consider whether this same data could be used by state law enforcement officials in ways that compromise Fourth Amendment protections against unconstitutional search and seizures.

**Prioritization Reasoning**

Loftus-Otway and Gallun (updated 2018) highlighted current federal provisions and recommendations for states to consider surrounding privacy, particularly with regard to event data recorder data and third-party access to data. This is an instructive area for states to review as they consider what types of modifications may be necessary and the expected role of the federal government in this area. Level 3–5 ADS-equipped or connected vehicles carry the promise of enhanced efficiency, increased safety, and other benefits. As the automation increases, however, and cars move towards levels 4–5, more and more data will be generated, collected, stored, transmitted, and shared. This data will include vehicle system data and accessory system data, as well as PII from owners’, drivers’, and passengers' personal devices. Vehicles and their systems will be at risk for unauthorized access, hijacking, and theft, putting PII at risk for unauthorized access and use.

Stakeholders also prioritized privacy and data concerns (Serian et al., 2017). However, since privacy and the use of PII is currently included in state and federal laws, stakeholders did not indicate the need for modifications in this area. Stakeholders generally recognized that data should be shared with the courts, DMVs, DOTs, insurance interests, vehicle operators, and defense attorneys, but there was minimal support for sharing data with other third-party entities. Almost all stakeholders indicated that the sharing of any data with third parties would need to be regulated or legislated, with the majority of stakeholders viewing the oversight of privacy and data protection as a shared responsibility between federal and jurisdictional governments. This sharing could take the form of federal oversight with state enforcement. One resource stakeholder stressed the need to address privacy and data security in a uniform and consistent manner, noting that data security measures in particular are typically implemented by companies in a manner that crosses state and global boundaries and privacy matters are currently addressed in both federal and state laws. As such, public-private collaboration among all stakeholders (including private industry, international, federal, and state governments) is appropriate.

Some states have begun to address the issue of data protection and privacy. Examples of enacted legislation surrounding privacy and data usage are limited. Following (Table 7) is California’s approach to addressing information privacy in its deployment express terms.
Table 7. CA Approach to Information Privacy

CA Veh. Cod., Title 13, Div. 1, Ch. 1, Article 3.7, §228.24, 2017

(a) The manufacturer shall either:

(1) Provide a written disclosure to the driver of an autonomous vehicle, and for vehicles that do not require a driver, the occupants of the vehicle, that describes the information collected by the autonomous technology that is not necessary for the safe operation of the vehicle; or,

(2) Anonymize the information that is not necessary for the safe operation of the vehicle.

(b) If the information is not anonymized, the manufacturer shall obtain the written approval of the operator of an autonomous vehicle to collect any information by the autonomous technology that is not necessary for the safe operation of the vehicle.

(c) A manufacturer shall not deny use of an autonomous vehicle to any person on the basis that they do not provide the written approval specified in subsection (b) of this section.

It is important that NHTSA drive the consistency of sharable data on vehicles. However, it is likely that states will also need to address the use and availability of data based on overall state goals and individual state leadership.

Prioritization and Harmonization Recommendations

**Prioritization Recommendation:** States and their associations should review open records statutes and user and vehicle data use and availability statutes to address any needed modifications. They should also closely monitor activities at the federal level regarding data privacy. Since the collection, storage, and use of the data from connected vehicles carry such significant privacy risks, regulators such as NHTSA, the Intelligent Transport Systems Joint Program Office, Federal Trade Commission, and Federal Communications System, as well as the auto industry itself, must prepare regulations or standards to minimize those risks. Whether at the federal level or the state level, the benefits from improved technology in C/ADSs will need to be balanced against the growing need for data security and privacy to instill public confidence in these vehicles.

**Harmonization Recommended:** No. Not currently harmonized at the state level; no specific reason to harmonize for C/ADS

**Short-Term Recommendation 5: User Attentiveness Provisions**

Only a few states require the driver to be fully attentive during the DDT, but when these conditions apply, they limit the use of level 3–5 C/ADS-equipped vehicles. There are also several different requirements...
C/ADS Legal and Regulatory Prioritization and Harmonization Assessment

that regulate user behavior and demand a heightened level of attentiveness. Although the requirements are dispersed throughout the reviewed vehicle codes, some will require modification.

**Prioritization Reasoning**

All state codes appear to allow C/ADSs, particularly at level 3 and below when there is a human person seated behind the controls. A few states actually require that a human driver be attentive and control the vehicle at all times or devote full time and attention to the operation of the vehicle. Other state codes note that “drivers” must be in reasonable control of the vehicle. States should review alertness requirements and user attentiveness provisions in their motor vehicle codes, as they may deter the use of automation and negate some C/ADS user benefits. States with prohibitions against inattentive users will most likely need to modify related statutes.

Modifications should include definitions or clarifications for operating and attentiveness on the part of a human within a driving automation system-equipped vehicle when lower levels (level 2 and below) of automation are deployed, and where they may be required to take over operations of a vehicle, be seated in the driver's seat, and/or awake. Driver attentiveness statutes may also have detrimental effects on the launch and operation of A-MaaS providers, as these services are predicated on the assumption that passengers will have no required level of attentiveness nor be required to assume control of a level 5 C/ADS-equipped vehicle. These statutes may also limit the operation of A-MaaS vehicles without any passengers awaiting instructions for the next pick up or while en route to pick up a passenger.

**Prioritization and Harmonization Recommendations**

| Prioritization Recommendation: States should review all statutes related to driver attentiveness and inattentive driving and consider modifications to these anti-distraction provisions depending on the level of driving automation system deployed. |
| Harmonization Recommended: No. Not currently harmonized at the state level; no specific reason to harmonize for C/ADS |

**Short-Term Recommendation 6: Rules of the Road**

States should identify and determine whether the rules of the road apply to C/ADSs and make appropriate modifications to motor vehicle laws. Some states have indicated in newly developed statutes that all provisions of rules of the road and accompanying penalties apply to level 4–5 C/ADS-equipped vehicles. Additionally, when these rules apply to “drivers,” clarification is needed as to who or, in the case of level 4–5 C/ADS-equipped vehicles, what that “driver” is to ensure that C/ADSs are not exempted from rules of the road requirements.

**Prioritization Reasoning**

In addition to standard rules of the road (speed limits, passing restrictions, etc.), rules of the road often apply standards of due care, such as yielding to a blind person, right of way for funeral processions, and yielding to school buses or ice cream trucks. While level 4–5 C/ADSs may have sensory means to address these issues, states still need to consider these issues at all levels. Visibility is a trigger for a number of rules of the road requirements and states ultimately may need to modify or clarify these visual cue requirements to tailor them more specifically to the capabilities of C/ADSs.
Stakeholder feedback, especially from law enforcement, indicated that it should be presumed that all vehicles, whether C/ADSs or traditional, need to follow existing rules of the road (Serian et al., 2017).

**Prioritization and Harmonization Recommendations**

- **Prioritization Recommendation:** States should review all rules of the road with an eye to the “human” element and implement provisions that apply to all drivers and vehicles as appropriate. Visual cues should also be reviewed. Benchmarks may need to be modified or adjusted by policy makers to accommodate the sensory abilities of C/ADS-equipped vehicles operating at level 3 or above.

- **Harmonization Recommended:** No. Not currently harmonized at the state level; no specific reason to harmonize for C/ADS

**Short-Term Recommendation 7: Local Restrictions**

Local restrictions are one of the overarching priority considerations discussed earlier in this report. The UVC and some states provide explicit powers to local authorities to override the state laws in their motor vehicle codes. The sharing of powers and responsibilities between the states and localities with respect to C/ADSs may be a major impediment unto itself. Most of these challenges, however, lie beyond motor vehicle codes. Given the importance and scope of this issue, we spotlight this type of provision, both for rules of the road and platoons. State-local cooperation, authorized by the law, may need refining or modification in the future in some states. Moving forward, states should begin reviewing existing statutes that allow for local control/local restrictions in light of level 3 and above C/ADS-equipped vehicle deployment.

**Prioritization Reasoning**

Local controls over roadways, with regard to both who can operate on them and the rules of the road, is an area that is likely to require the examination of local restrictions statutes. If these requirements need to be adjusted for C/ADSs, then state laws may need to be modified in ways that will involve significant policy choices. Alternatively, if new programs or directives are needed to ensure closer harmonization between states and localities, then this is an area for wholly new legislative or regulatory activity. Various levels of authority can impede commerce and have implications on harmonization for future C/ADS deployment. Following are examples of state-enacted local restrictions statutes.

- **North Carolina.** House Bill 469 notes that, “No local government shall enact any local law or ordinance related to the regulation or operation of fully autonomous vehicles or vehicles equipped with an automated driving system, other than regulation specifically authorized in Chapter 153A and Chapter 160A of the General Statutes that is not specifically related to those types of motor vehicles” (An Act to Regulate the Operation of Fully Autonomous Motor Vehicles on the Public Highways of this State, 2017).

- **Illinois.** Public Act 100-0352 notes that, “A unit of local government, including a home rule unit, may not enact an ordinance prohibiting the use of Automated Driving System equipped vehicles on its roadways” (An Act Concerning Transportation, 2017).
Prioritization and Harmonization Recommendations

Prioritization Recommendation: Some states’ codes provide local governments with authority to regulate traffic and impose local restrictions in addition to state restrictions. To the extent that local provisions would be stricter than state code restrictions, states should work with local governments to determine if the local controls should remain in place with deployment of level 3 and higher C/ADS-equipped vehicles.

Harmonization Recommended: No. Not currently harmonized at the state level; no specific reason to harmonize for C/ADS

Short-Term Recommendation 8: Aftermarket Technologies

The application of existing state laws to aftermarket conversions of conventional vehicles into ADS-equipped vehicles remains unclear. Existing laws should be revised or clarified. In addition, aftermarket modifications should be classified and DMVs notified via a state-determined process if C/ADSs are installed on a vehicle. States should be aware that NHTSA governs vehicle safety equipment, and state revisions to this area of law are subject to federal preemption.

Prioritization Reasoning

Fourteen jurisdictional and resource stakeholders noted that the modification of current vehicles to level 4–5 C/ADS-equipped vehicles should be regulated. Three of the resource stakeholders qualified their response by indicating that the regulation should only occur in certain instances, such as when the modification would enable a different level of driving automation system to engage (Serian et al., 2017).

Several modifications to existing laws and/or regulations would be required to permit or prohibit these type of aftermarket modifications, including those related to jurisdictional registration and inspection statutes, certifications, FMVSS requirements for safe conversions, insurance, and OEM liability.

In terms of who should be performing the certification/inspection of modifications, it was suggested that this be performed by licensed/registered aftermarket companies/installers to ensure the vehicle will actually perform at the indicated level. (Serian et al., 2017). Further, if an SAE J3016 level of automation becomes part of the vehicle record, certification will be required to update the record accordingly.

There is little legislative activity in this area. Nevada recently passed AB 69, which does extend immunity from liability for damages caused by modifications by an unauthorized third party to the original manufacturer or developer of a C/ADS. (An Act Relating to Transportation, 2017). And while the possibility of aftermarket C/ADS downloads has been discussed, none have yet been mass produced for the market. However, this is an area that is likely to be part of the ongoing C/ADS conversation and states should prepare early on for these possible modifications.
Harmonization Reasoning

*ADS-Equipped Passenger Vehicles and A-MaaS*

Urgency for harmonization is also noted regarding aftermarket C/ADSs, in which passenger vehicle owners convert a level 0 or level 1–2 driving automation system-equipped vehicle into a level 3–5 C/ADS-equipped vehicle through the addition of sensors and other automated driving technology (Serian et al., 2017). Wagner et al. (2018) notes that under both the UVC and some state laws, consumer modifications of vehicles are regulated. Most of these laws, however, seem to engage only at the inspection stage, if at all. This means that most aftermarket modifications remain largely unregulated. This market could potentially become unsafe unless governments establish clear boundaries regarding modification of existing vehicles with C/ADS capabilities. From a harmonization standpoint, the possibility of unsafe aftermarket modifications endangers all road users, regardless of the state in which the vehicle operates. Therefore, early harmonization is important to avoid a “vehicle automation outfitter” setting up shop in the state with the least stringent rules on such modifications. Here, upwards harmonization is needed to establish a high-quality standard.

Prioritization and Harmonization Summary

| Prioritization Recommendation: | States should begin to consider how they will address, legislate, or regulate aftermarket C/ADSs. Current laws and regulations may need to be revised or clarified with respect to whether and how they regulate aftermarket driving automation system-related technologies installed on a vehicle. |
| Harmonization Recommended: | Yes. Guidelines (policy decision) |
| Consumer C/ADS application(s) affected first: | C/ADS-equipped passenger vehicles and A-MaaS |

*Short-Term Recommendation 9: Unattended Vehicles*

Prioritization Reasoning

States should consider clarifying the meaning of laws that prohibit unattended vehicles, especially for level 4–5 C/ADS-equipped vehicles. While mass deployments of passenger vehicles operating at these levels are beyond the mid-term timeframe, this legal area will still need to be considered for A-MaaS vehicles in the short-term.

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10 Ohio’s regulations, for example, state that “[e]ach inspection of a motor vehicle assembled from component parts by a person other than the manufacturer as provided in section 4505.111 of the Revised Code shall include inspection for identification for all component parts used to build the particular vehicle.” Oh. Admin. Code § 4501-33-05(A). Whether conversions of conventional vehicles to C/ADSs meet this definition appears to be an additional legal question in the application of this provision to automated aftermarket modifications.

11 For one example of how extensive this aftermarket modification activity might become, see https://medium.com/@comma_ai/our-road-to-self-driving-victory-603a9ed20204
Harmonization Reasoning

C/ADS and A-MAAS

States and A-MaaS providers will both benefit from the harmonization of the meaning and application of laws that prohibit unattended vehicles. Unattended vehicles represent a public nuisance in that they can block traffic and block use of the roadway shoulder by emergency first responders. To address this concern, states generally include in their motor vehicle codes the prohibition of drivers leaving their vehicles unattended (except for parking). Under this law, however, an empty A-MaaS C/ADS-equipped vehicle operating without any passengers or any driver could be considered “unattended” because the engine is running and the brake is not applied. The ability for an A-MaaS vehicle to operate while empty, presumably on its way to pick up a passenger, is central to the development of this business model. This effort should be undertaken in the short term and harmonized to establish uniformity and clarity of the term “unattended” and its applications, as A-MaaS-focused efforts to harmonize will eventually apply to C/ADS-equipped passenger vehicles (e.g., for self-parking) as well.

Prioritization and Harmonization Summary

| Prioritization Recommendation: | Clarify the meaning of laws that prohibit unattended vehicles, especially for level 4–5 C/ADS-equipped vehicles, including A-MaaS fleet vehicles. |
| Harmonization Recommended: | Yes. Best practices language |
| Consumer C/ADS application(s) affected first: | A-MaaS |

Short-Term Prioritization and Harmonization Recommendation Summary

In the next 2 years (2018–2020), modifications to the following state motor vehicle code provisions are suggested for consideration (Table 8). Note, items below are not ordered chronologically.
## Table 8. Short-Term Prioritization and Harmonization Modification Recommendations

<table>
<thead>
<tr>
<th>RECOMMENDATION</th>
<th>HARMONIZATION RECOMMENDED?</th>
<th>CONSUMER C/ADS APPLICATION AFFECTED FIRST</th>
<th>MEANS OF ADDRESSING</th>
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<tbody>
<tr>
<td><strong>DEFINITIONS AND DRIVER ONLY VEHICLE CODES</strong></td>
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<tr>
<td>Conduct a critical review of fundamental vehicle code terms “drive,” “driver,” “operate,” and “operator,” and develop necessary clarification in terms, intent, and interpretation.</td>
<td>Harmonization recommended</td>
<td>C/ADS-equipped passenger vehicles and A-MaaS</td>
<td>Best practice language</td>
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<tr>
<td>Address the possibility that vehicle codes can be interpreted to regulate only “drivers” (who are licensed and human) and exempt level 4–5 C/ADS-equipped vehicles from legal oversight.</td>
<td>Harmonization recommended</td>
<td>C/ADS-equipped passenger vehicles and A-MaaS</td>
<td>Guidelines (policy decision)</td>
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<tr>
<td><strong>PLATOON-RELATED ISSUES</strong></td>
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<tr>
<td>Consider the need to modify following distance requirements for platoons on a state’s highways. This is particularly important in states that impose prescriptive following distances. Additionally, provide guidance and clarify the legal classification of truck platoons.</td>
<td>Harmonization recommended</td>
<td>Platooning ADS-equipped CMVs</td>
<td>Best practice language; receive guidance (e.g., from the Commercial Vehicle Safety Alliance)</td>
</tr>
<tr>
<td>Develop restrictions as needed if technical scan/engineering analyses identify any negative length, weight, and/or noise effects due to trucks operating as a platoon. Further, audit state laws and regulations that may impose lane restrictions or service requirements on platoons to develop harmonization across the state.</td>
<td>Useful but not essential</td>
<td>Platooning ADS-equipped CMVs</td>
<td>Best practice language; receive guidance (e.g., from the Commercial Vehicle Safety Alliance)</td>
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<td><strong>VEHICLE TITLING AND REGISTRATION</strong></td>
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<tr>
<td>Memorialize, from the time of manufacture to junk or salvage on title and registration documents, that the vehicle is driving automation system-equipped. Consider memorialization of aftermarket technologies.</td>
<td>Harmonization recommended</td>
<td>C/ADS-equipped passenger vehicles and A-MaaS</td>
<td>Guidelines (policy decision)</td>
</tr>
<tr>
<td>RECOMMENDATION</td>
<td>HARMONIZATION RECOMMENDED?</td>
<td>CONSUMER C/ADS APPLICATION AFFECTED FIRST</td>
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<tr>
<td><strong>PRIVACY PROTECTIONS</strong></td>
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<tr>
<td>Assess state policy protections for privacy-sensitive data collected on vehicles through connected infrastructure and vehicle transmission and also the implications of open records laws and the applicability of current state privacy protection statutes.</td>
<td>No harmonization recommended</td>
<td>Not currently harmonized at the state level; no specific reason to harmonize for C/ADSs.</td>
<td></td>
</tr>
</tbody>
</table>

| **USER ATTENTIVENESS** |
| Modify prohibitions against inattentive drivers depending on level of driving automation system deployed. | No harmonization recommended | Not currently harmonized at the state level; no specific reason to harmonize for C/ADSs. |

| **RULES OF THE ROAD – APPLICABILITY TO C/ADS** |
| Identify how and whether the rules of the road apply to different levels of driving automation systems. Ensure that level 4–5 C/ADS-equipped vehicles are not exempted from rules of the road requirements. | No harmonization recommended | Not currently harmonized at the state level; no specific reason to harmonize for C/ADSs. |

| **RULES OF THE ROAD – LOCAL RESTRICTIONS** |
| Modify local controls over roadways for who can operate on them, the rules of the road, and consider issues of state level preemption. | No harmonization recommended | Not currently harmonized at the state level; no specific reason to harmonize for C/ADSs. |
### 5.2 Mid-Term (2021–2025) Priorities and Harmonization Recommendations

The mid-term timeframe of 2021–2025 will see significant change in terms of vehicles at different SAE J3016 levels of automation. We anticipate an increasing number of level 3 C/ADS-equipped passenger vehicles, the introduction of level 4 C/ADS-equipped A-MaaS vehicles, and the early introduction of level 4 C/ADS-equipped passenger vehicles. The most significant and rapid change is expected to happen during this period. The following law and/or regulation code changes are recommended in advance of this timeframe.

Recommended harmonization for C/ADS-equipped passenger vehicles and A-MaaS vehicles are included below. No mid-term harmonization requirements for trucking have been identified, at least in terms of current motor vehicle codes. However, one aspect of new regulations may come in the form of signage and/or indicators identifying platooning level 1 or level 2 driving automation system-equipped CMVs and/or “platooning currently underway.” This is an area of active and unsettled discussion within several states. As truck platoons proliferate over the next few years, it would be valuable to harmonize any new requirements, particularly those that impact truck design. For instance, while placarding for platooning capability is relatively simple, implementing an electrical/electronic “platoon in operation” indicator impacts hardware design and should be consistent across states.

**Mid-Term Recommendation 1: User Qualifications, Testing, and Driver Education**

States should expect to modify licensing qualifications and requirements and determine if additional user testing and education is necessary. This effort goes well beyond the issuance of a digital or physical credential with an “ADS-equipped” designation. States will also need to look at any underlying reasons citizens have NOT been able to obtain a license to drive and if those issues can be resolved in level 4–5 C/ADS-equipped vehicles. These reasons might include medical competency provisions, sight
restrictions, or other physical restrictions. Regulations governing medical competency boards should also be reviewed to determine possible changes in representation and skill sets. By this point, states should have addressed the underlying fundamental definitions of “drive,” “driver,” “operate,” and “operator,” making a review of these types of provisions less daunting.

Prioritization Reasoning

Some examples of state efforts in this area include the following.

**Pennsylvania.** The Pennsylvania DOT recognized the likelihood and opportunity of addressing medical impairment. An earlier study prepared by Carnegie Mellon University for the DOT noted that changes to laws or regulations would be needed for ADS-equipped vehicles at the currently defined SAE J3016 levels of automation (Hendrickson, C., et al, 2014).

**Georgia.** Georgia State Bill 291 amends the Official Code of Georgia by definition “to exempt persons operating a fully autonomous [level 5] motor vehicle with the automated driving system engaged from the requirement to hold a driver's license.” The exemption is based on this enacted definition: “‘Fully autonomous vehicle’ means a motor vehicle equipped with an automated driving system that has the capability to perform all aspects of the DDT without a human driver within a limited or unlimited operational design domain and will not at any time request that a driver assume any portion of the DDT when the automated driving system is operating within its operational design domain” (A Bill To Be Entitled: An Act to amend Title 40 of the O.C.G.A., 2017).

**Nevada.** Nevada requires the following: “a person who holds a driver’s license in [Nevada] and wishes to operate an autonomous vehicle in autonomous mode in [Nevada] must obtain a G endorsement on his or her driver’s license from the Department.” This endorsement is required by regulation. An autonomous vehicle is described as a vehicle that can “carry out all the mechanical operations of driving without the active control or continuous monitoring of a natural person” (Nev. Rev. Stat. § 482A, 2013).

Testing components should also be reviewed during this time, and states might consider adding level 4–5 C/ADS component language to existing driving tests to help ensure that the user understands the functional limits of the C/ADS’s functional limits. Some of these terms may include C/ADS, DDT, minimal risk condition, operator and driver, and ODD limits.

Education requirements will similarly need to be examined for possible inclusion of new provisions and units to help users understand the appropriate times to engage and disengage an ADS, as well as how to operate during a handoff situation. Similar consideration should be given to how to interact with level 4–5 C/ADS-equipped vehicles.

Stakeholder responses were in line with the Federal Automated Vehicle Policy (NHTSA, 2016) on driver licensing, recognizing that federal preemption may be needed when the “driver” is the technology. Jurisdictional stakeholders saw a need for increased driver training, especially during the years when the fleet is mixed. Resource stakeholders recommend that the federal government set a federal minimum level of mandated licensing requirements for level 4–5 C/ADS-equipped vehicles. This is highly inconsistent with the current state role of licensing non-commercial drivers. Input was mixed on the need for a special classification of driver’s license. However, there was a clear recognition that basic requirements in law and regulation may need to change to impose fewer restrictions (e.g., visual acuity, driver fitness, physical disabilities; Serian et al., 2017).

Jurisdictional stakeholders were split as to whether at least one occupant of a level 4–5 C/ADS-equipped vehicle should be required to hold a driver's license, and whether a special type of designated license or
endorsement for licensing of level 4–5 C/ADS-equipped vehicle users would be needed. When clarifying their responses for non-commercial driver's licensing, stakeholders indicated different licensing requirements for different SAE J3016 levels of automation, increased focus on technological aptitude standards and less rigorous skills-based aptitude testing, the potential to lift or modify age and physical restriction requirements, and redefining the “driver” as the C/ADS and implementing C/ADS compliance monitoring.

Resource stakeholders noted an increased need for federal involvement in mandating minimum driver licensing qualifications, with the ability for states to enact more stringent standards (Figure 12; Serian et al., 2017). This is similar to today’s REAL ID or commercial driver’s licensing (U.S. Department of Homeland Security, 2017). Resource stakeholders also noted a need to ensure proper education and training during the period of interoperability and the potential for alternate driver’s licenses for varying SAE J3016 level of automation. In addition, resource stakeholders suggested potential changes to the testing process to include C/ADS features, including legal requirements for providing notice to DMVs when aftermarket modifications are made.

Both jurisdictional and resource stakeholders noted a potential need to work with manufacturers, either to ensure that their representatives are providing training or to demonstrate that their operating systems can pass all driver functionality tests (i.e., can pass a driver’s license test for C/ADSs; Serian et al., 2017)

Any changes to issuance requirements, testing, or training will be on a state-by-state basis and are likely to intersect with federal mandates or requirements for non-commercial drivers in this area. The emphasis needs to be on reciprocity and best practices or model minimum standards developed by the states in concert with AAMVA (Figure 13).
Figure 13. Need for changes to testing requirements for users of conventional vehicles as level 4–5 ADS-equipped vehicles are deployed.

The aforementioned report prepared for the Pennsylvania DOT recommended that driving and skill tests should be required for all SAE J3016 levels of automation with the exception of what is currently defined as level 5, where there is no interaction between drivers and vehicles (Hendrickson et al., 2014). The report also noted that testing for all SAE J3016 levels of automation should be updated initially and also periodically to assure the user’s basic familiarity with electronic assist features as well as required interactions between drivers and vehicles.

Changes in this area will be incremental and informed by the technology. In reality, user testing components are likely to be driven by policy and not law in most states, and user education is clearly state based. So, while states should review their laws and regulations for testing and education, the much more pressing component is user qualification, particularly adjustments to allow those who could not “drive” before to “drive” now.

**Harmonization Reasoning**

**C/ADS-Equipped Passenger Vehicles and A-MAAS**

Many A-MaaS companies promise their services will launch in the 2021 to 2025 timeframe (Ford, 2017; Bosch Media Service, 2017; Townsend, 2016). As such, the transition from testing with a safety driver in the vehicle to Level 4 C/ADS-equipped A-MaaS vehicle will require several changes to state vehicle codes and will benefit from state harmonization.

One such case can be found in the provisions of the code that specify who may and may not operate a vehicle. Among the most heavily promoted benefits to come from self-driving cars is improved access and mobility for all (Duncan et al., 2015; Douma, Lari, & Andersen, 2017; National Association of City Transportation Officials, 2016). Today, state motor vehicle codes limit or prohibit entirely certain individuals from obtaining licenses and operating motor vehicles through provisions requiring vision and operating tests. To fully reach the potential benefits of C/ADSs (including C/ADS-equipped passenger vehicles), states will need to address the barriers that currently prevent many people from simply riding as passengers in level 4 or 5 C/ADS-equipped vehicles. However, while harmonization seems useful here,
stakeholders did not indicate that overcoming these barriers automatically meant a need for harmonization (Figure 14).

![Figure 14. Stakeholders' perceived need for the harmonization of training and testing laws and regulations.](image)

**Prioritization and Harmonization Recommendations**

- **Prioritization Recommendation:** Determine who can operate C/ADSs at different SAE J3016 levels of automation and adjust the law for driver licensing requirements.

- **Prioritization Recommendation** Develop driving tests (or amend existing tests) keyed to the different SAE J3016 levels of automation.

**Harmonization Recommended:** Useful, but not essential. Reciprocity agreements, best practice language

**Consumer C/ADS application(s) affected first:** C/ADS-equipped passenger vehicles and A-MaaS

**Mid-term Recommendation 2: Reasonable Articulable Suspicion (Implied Consent)**

**Prioritization Reasoning**

States should consider when a “reasonable articulable suspicion” of alcohol or drug use is appropriate in settings where the system is controlling a level 4–5 C/ADS-equipped vehicle. For example, if it is possible for law enforcement to confirm at the scene that the C/ADS was properly engaged at the time of a violation or crash, there can be no presumption of a “reasonable articulable suspicion” of impaired driving.

As discussed below, amendments to implied consent would seem logically to lead to parallel allowances for drinking for C/ADS operators under conditions that allow for safe operation for high levels of automation. Yet the latter decision would involve more comprehensive standards and public decisions about when drinking is and is not allowed in operating vehicles. Adjustments to implied consent for
higher levels of automated driving will not lead to the automatic legalization of alcohol consumption while driving.

**Prioritization and Harmonization Recommendations**

<table>
<thead>
<tr>
<th>Prioritization Recommendation: Consider when a “reasonable articulable suspicion” of alcohol or drug use is appropriate in settings where the C/ADS is engaged in a level 3–5 ADS-equipped vehicle.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Harmonization Recommended: No. Assumes definitions are modified to clarify users are considered passengers when traveling in a level 4–5 C/ADS-equipped passenger vehicle or A-MaaS.</td>
</tr>
<tr>
<td>Consumer C/ADS application(s) affected first: C/ADS-equipped passenger vehicles and A-MaaS</td>
</tr>
</tbody>
</table>

**Mid-Term Recommendation 3: Prohibitions Against Use of Alcohol and Legal Drugs**

The UVC and all states prohibit a person from driving while intoxicated or under the influence of drugs or narcotics. The UVC directs that a person shall not drive any vehicle while “under the influence of alcohol” or “any drug to a degree which renders such person incapable of safely driving” or that exceeds prescribed blood concentrations set in the statute (UVC § 11-901). In most states, these general prohibitions are reinforced by legislative limits on alcohol and drugs in the driver. Nevada’s statutes are illustrative: it is unlawful for a person to drive if he or she “[h]as a concentration of alcohol of 0.08 or more in his or her blood or breath; or . . . is found by measurement within 2 hours after driving . . . to have a concentration of alcohol of 0.08 or more in his or her blood or breath” (NV Rev. Stat. § 484C.110). In most states, alcohol for commercial vehicles and for minors are generally stricter, sometimes approaching a zero-tolerance level (See, e.g., CA Veh. § 6-51 [commercial vehicles]; § 11-905 [zero tolerance for minors]).

**Prioritization Reasoning**

States will need to clarify alcohol and drug use and regulation within the various SAE J3016 levels of automation (including in states where marijuana has been legalized). For example, for higher levels of automation, states may decide to allow operators to consume alcohol in advance of or during driving. If alcohol consumption is allowed for some levels of automation, this legal modification will also impact the implied consent requirements discussed above. Implied consent for higher levels of automation may need to be adjusted or even eliminated entirely.

**Prioritization and Harmonization Recommendations**

| Prioritization Recommendation: Clarify alcohol and drug use and regulation within the various SAE J3016 levels of automation (including in states where marijuana has been legalized). Develop offenses, fines, and sentencing terms at varying levels of automation. Adjust implied consent requirements accordingly. |
| Harmonization Recommended: No. Not currently harmonized at the state level; no specific reason to harmonize for C/ADS |
Mid-Term Recommendation 4: Motor Vehicle Liability

Prioritization Reasoning

Some crashes, incidents, and harms will be the result not of human driver error, but rather flaws in the engaged ADS when it is in control of the vehicle. Some state laws currently place full legal responsibility for any damages and harms on the human driver and preclude any manufacturer liability. Policy makers should consider whether it is more equitable to place primary responsibility on vehicle manufacturers and technology companies when the ADS is engaged and in control of the vehicle, or at least include partial responsibility for manufacturers. There is also a parallel need to define the process for determining who was in charge of driving at the time of the crash (likely by modifying electronic recording device regulations, typically a federal responsibility).

Harmonization Reasoning and Recommendations

Policy makers should consider whether it is more equitable to place primary responsibility on vehicle manufacturers and technology companies when the ADS is engaged and in control of the vehicle, or at least include partial responsibility for manufacturers. Harmonization for all consumer C/ADS applications (including A-MaaS) is recommended.

Prioritization and Harmonization Recommendations

- **Prioritization Recommendation:** Determine responsibility for crashes, incidents, and harms that may not be the results of human operator errors, but rather flaws in the ADS as operating at the time of the incident.

- **Harmonization Recommended:** Useful, but not essential. Best practice language

- **Consumer C/ADS application(s) affected first:** C/ADS-equipped passenger vehicles (later) and A-MaaS (now)

Mid-Term Recommendation 5: Due Care Standard

Policy makers should clarify how the “due care” standard applies when a vehicle is operating at SAE J3016 levels 3–4. Presumably, there are “due care” considerations applied to the human driver with respect both to whether to engage the ADS and whether to override or disable the ADS in specific settings. Since these types of “due care” actions currently have no reliable benchmark in human experience, states should define what these terms might mean in different technological and operational scenarios.

Prioritization Reasoning

Throughout the UVC and the state motor vehicle codes, users are regularly instructed that they must exercise “due care,” act “reasonably” and with “prudence” and avoid “carelessness” to comply with the rules of the road. Illustrative examples of state statues include the following:

Nebraska simply requires that “[a]ny person who drives any motor vehicle in this state carelessly or without due caution so as to endanger a person or property shall be guilty of careless driving” (NE Rev. Statutes § 60-6,212).
In California, the “driver of a motor vehicle when reasonably necessary to insure safe operation shall give audible warning with his horn.” This “reasonable and prudent” directive is unavoidably benchmarked against human judgment.

It seems likely that C/ADS programmers can match and exceed good human judgment in most cases, but in other, more complex settings (e.g., “traveling upon any narrow or winding roadway, and when special hazards exist”) the C/ADS may not fully grasp the situation as a prudent human would (NE Rev. Statutes § 60-6,212). In some cases, human decision-making abilities, coupled with multi-sensory cues, assist in making this “reasonable” judgment required by law (UVC § 11-304). Similarly, passing streetcars or driving on street car tracks invoke some state requirements that the driver “proceed only upon exercising due caution for pedestrians” exiting and around the streetcar (UVC § 11-1401—1404).

C/ADSs raise still more challenges with regard to this human judgment requirement by presenting a possible bifurcated “reasonable person”—one who is human driving a non-C/ADS-equipped vehicle and the other driving, for example, a level 3 C/ADS-equipped vehicle with the ADS engaged. What a reasonable human might do rounding a sharp curve may be different than what a reasonable human operating in a level 3 ADS-equipped vehicle would do given the dramatic differences in vehicle capacities. This fact only further underscores how these judgment-based provisions may complicate how compliance is assessed at different SAE J3016 levels of automation.

Prioritization and Harmonization Recommendation

Prioritization Recommendation: Modify or adjust benchmarks to accommodate the decision-making abilities of level 3–5 ADS-equipped vehicles, especially for the “due care” standard.

Harmonization Recommended: No. Not currently harmonized at the state level; no specific reason to harmonize for C/ADS


Prioritization Reasoning

Most states prohibit driver distractions, which can take the form of video screens, texting, earphones, and even grooming. None of these provisions impede the use of C/ADSs and none create safety hazards. Nonetheless, given the features of C/ADSs, some of these provisions may need to be modified as the fleet evolves into SAE J3016 levels 4–5. In particular, level 5 C/ADS-equipped vehicles operating as part of an A-MaaS fleet will assume no passenger responsibility for attentiveness nor have any expectation that the passenger will retake control of the vehicle.

Prioritization and Harmonization Recommendations

Prioritization Recommendation: Modify anti-distraction provisions to enhance the utility of level 4–5 ADS-equipped vehicles for those who would benefit from their use.

Harmonization Recommended: No. Not currently harmonized at the state level; no specific reason to harmonize for C/ADS
Mid-Term Recommendation 7: Unfair Criminal and Civil Sanctions on Users

Prioritization Reasoning

Drivers can be charged with criminal acts for violating certain traffic laws, but in the case of level 4–5 C/ADS-equipped vehicles, some of these criminal charges are less straightforward. Certain provisions may assign criminal liability to a human operator in situations where the vehicle could be completely to blame, or at least largely responsible, for resulting harms or violations. For example, in vehicles operating at SAE J3016 levels 4–5, C/ADS malfunctions may cause the vehicle not to register a visual or audible signal from law enforcement, creating criminal liability for the human operator. Criminal acts that could be a result of C/ADS malfunctions need to be reviewed in vehicle codes as do assumptions of liability against OEMs, suppliers, technology companies, and A-MaaS network companies.

Harmonization Reasoning

With many OEMs and new entrants in the manufacturing sector targeting this time range for deployment, states will need to harmonize their vehicle codes in advance. This will involve addressing several new areas of policy and considering major operational issues for C/ADSs, such as liability and faults associated with flaws in the ADS as engaged at the time of the event of interest. Harmonization is thus recommended for level 3–5 C/ADS-equipped passenger vehicles.

Prioritization and Harmonization Recommendations

**Prioritization Recommendation:** Amend statutes governing criminal and civil liability to leave open the possibility that a level 3–5 C/ADS-equipped vehicle with a properly engaged ADS could also be responsible in whole or in part for a resulting violation.

**Harmonization Recommended:** Yes. Best practices language

**Consumer C/ADS application(s) affected first:** C/ADS-equipped passenger vehicles and A-MaaS

Mid-Term Recommendation 8: Crash Reporting and Rendering Aid

Prioritization Reasoning

States should consider reviewing and modifying rendering aid statutes. These “report and render aid” provisions can create two separate challenges for level 4–5 C/ADS-equipped vehicles. The first challenge is that compliance requires a human. Thus, in cars without an active operator or even able occupants, compliance with the requirements may be difficult, if not impossible. The second challenge returns to the problem of definitions. The render aid requirements focus their mandates on the terms “drivers” and “operators.” It is possible that if a level 4–5 C/ADS-equipped vehicle operating without a human aboard causes an accident, it could be exempt from these provisions since there is no “driver.”

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12 See also Glancy et al., A Look at the Legal Environment for Driverless Vehicles, NCHRP LEGAL DIGEST 69, at 43 (2015) (raising similar concerns about these provisions).

13 Like the illustrative UVC provision excerpted above, the state codes generally reference the “driver” of the vehicle involved in the accident as triggering the duty. Miss. Code Ann. §§ 63-3-401, 403, 405, 407, 409 (same duty applied to fixtures), 411, 423; SDCL §§ 32-34-2, 3.1, 4, 6, 7; see also Texas Transportation Code §§ 550.021—025 (references “operator” rather than “driver” but definition of operator is person in actual physical control for this particular requirement); Utah § 41-6a-401 (same).
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(human present in the car). Again, while most of the related deployment modifications apply to level 4–5 C/ADS-equipped passenger vehicles, this provision also applies to A-MaaS vehicles, which are expected to be deployed in the mid-term.

Prioritization and Harmonization Recommendation

Prioritization Recommendation: Modify rendering aid statutes for level 4–5 C/ADS-equipped vehicles to address the fact that a human driver may not be present in the vehicle.

Harmonization Recommended: No. Not currently harmonized at the state level; no specific reason to harmonize for C/ADS

Mid-Term Recommendation 9: Vehicle Requirements

Prioritization Reasoning

Most states impose specific types of requirements on the physical features of vehicles. While most of these vehicle requirements are open-ended and do not appear to impede C/ADSs, some do appear to pose potential impediments in the future (e.g., horns and other audible warning devices, steering wheels, mirrors, brake pedals). Level 4 and level 5 C/ADS-equipped vehicles, especially those that are ADS-DVs, may not conform to these requirements. As a result, certain vehicular requirements in state codes may become outmoded or unduly prescriptive in limiting the types of C/ADSs allowed in the state. As part of a detailed motor vehicle code audit, policy makers may want to consider identifying and modifying soon to be obsolete requirements so that more applicable terms are used (e.g., referring to “steering assemblies” rather than “steering wheels”/“wheels” or “braking systems” rather than “pedals”). The aforementioned NHTSA project, Assessment, Evaluation, and Approaches to Technical Translations of FMVSS and Test Procedures That May Impact Compliance of Innovative New Vehicle Designs Associated with Automated Driving Systems, is considering issues associated with vehicle requirements. States should be aware of this research effort and monitor NHTSA for findings related to the project.

Harmonization Reasoning

C/ADS-Equipped Passenger Vehicles and A-MaaS

Many features of the modern motor vehicle could become obsolete in C/ADSs, including items related to vehicle controls, such as brakes and a steering wheel (NHTSA, 2016b). Not only will these devices become unnecessary in level 4–5 C/ADS-equipped vehicles, they will likely be intentionally absent for level 5 vehicles utilized by A-MaaS services, as service providers will seek to prevent passengers from taking control of the vehicle. As such, states should ensure they harmonize vehicle codes and standards to enable A-MaaS vehicles to operate across state lines. Harmonization would also enable manufacturers produce a fleet that can operate throughout the U.S. without customizing vehicle design and operation on a state-by-state basis. A-MaaS-focused efforts to harmonize in this area apply to level 4–5 ADS-equipped passenger vehicles as well.
Prioritization and Harmonization Recommendations

**Prioritization Recommendation:** Begin to identify obscure requirements that reference specific items (use “steering assemblies” rather than “wheels” and “braking systems” rather than “pedals”) to address over the longer-term.

**Harmonization Recommended:** Yes. Reciprocity agreements and/or federal preemption (likely a policy decision)

**Consumer C/ADS application(s) affected first:** C/ADS-equipped passenger vehicles and A-MaaS

**Mid-Term Prioritization and Harmonization Recommendation Summary**

In summary, the following state motor vehicle code provisions are suggested for modifications in the short term (Table 9). Note, items below are not ordered in chronological manner.

**Table 9. Mid-Term Prioritization and Harmonization Modification Recommendations**

<table>
<thead>
<tr>
<th>RECOMMENDATION</th>
<th>HARMONIZATION RECOMMENDED?</th>
<th>CONSUMER C/ADS APPLICATION AFFECTED FIRST</th>
<th>MEANS OF ADDRESSING</th>
</tr>
</thead>
<tbody>
<tr>
<td>DRIVER LICENSING</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Determine who can operate driving automation systems at different levels of driving automation and adjust the law for driver licensing requirements.</td>
<td>Useful but not essential</td>
<td>C/ADS-equipped passenger vehicles and A-MaaS</td>
<td>Reciprocity agreements, best practice language</td>
</tr>
<tr>
<td>DRIVER TESTING AND EDUCATION</td>
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<td></td>
</tr>
<tr>
<td>Develop driving tests (or amend existing tests) keyed to varying levels of driving automation systems.</td>
<td>Useful but not essential</td>
<td>C/ADS-equipped passenger vehicles and A-MaaS</td>
<td>Reciprocity agreements, best practice language</td>
</tr>
</tbody>
</table>
### RECOMMENDATION

<table>
<thead>
<tr>
<th>HARMONIZATION RECOMMENDED?</th>
<th>CONSUMER C/ADS APPLICATION AFFECTED FIRST</th>
<th>MEANS OF ADDRESSING</th>
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</thead>
<tbody>
<tr>
<td><strong>IMPLIED CONSENT</strong></td>
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<tr>
<td>Consider when “reasonable articulable suspicion” of alcohol or drug use is appropriate in specific ODD with a properly engaged level 3–5 C/ADS-equipped vehicle.</td>
<td>No harmonization recommended</td>
<td>C/ADS-equipped passenger vehicles and A-MaaS</td>
</tr>
<tr>
<td><strong>PROHIBITIONS AGAINST USE OF ALCOHOL AND LEGAL DRUGS</strong></td>
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<tr>
<td>Clarify alcohol and drug use and regulation (including in states where marijuana has been legalized) within the various levels of driving automation. Develop offenses, fines, and sentencing terms for lower level violations at varying levels of driving automation.</td>
<td>No harmonization recommended</td>
<td>Not currently harmonized at the state level; no specific reason to harmonize for C/ADS</td>
</tr>
<tr>
<td><strong>MOTOR VEHICLE LIABILITY – USER AND OWNER LIABILITY FOR DAMAGES</strong></td>
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<td></td>
</tr>
<tr>
<td>Determine responsibility for crashes, incidents, and harms that may not be the result of human error but rather flaws in the C/ADS as engaged at the time of the event of interest.</td>
<td>Useful but not essential</td>
<td>C/ADS-equipped passenger vehicles (later) and A-MaaS (now)</td>
</tr>
<tr>
<td><strong>RULES OF THE ROAD – DUE CARE STANDARD AND HUMAN JUDGMENT</strong></td>
<td></td>
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<tr>
<td>Modify or adjust benchmarks to accommodate the decision-making abilities of level 3–5 C/ADS-equipped vehicles operating at level 3 or above, especially for the “due care” standard, which is tethered to human judgment.</td>
<td>No harmonization recommended</td>
<td>Not currently harmonized at the state level; no specific reason to harmonize for C/ADS</td>
</tr>
<tr>
<td><strong>USER DISTRACTIONS</strong></td>
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<tr>
<td>Modify anti-distraction provisions to enhance the utility of C/ADS-equipped vehicles for their drivers (while the ADS is unengaged) or passengers (while the ADS is engaged).</td>
<td>No harmonization recommended</td>
<td>Not currently harmonized at the state level; no specific reason to harmonize for C/ADS</td>
</tr>
</tbody>
</table>
### 5.3 Long-Term (2026 and beyond) Priorities and Harmonization Recommendations

Beyond the short- and mid-term changes needed, states should undertake several longer-term efforts after 2026, once the C/ADS market begins to reach greater penetration of the broader fleet. These include efforts to fully normalize and structure the operation of C/ADSs, both for personal use and under an A-MaaS service, such as through the adaptation of vehicle inspection requirements.

**Long-Term Recommendation 1: Vehicle Inspection**

**Prioritization Reasoning**

Some agency inspection laws and accompanying regulations will likely need to be modified to accommodate the new technological features of C/ADS-equipped vehicles, such as the absence of steering wheels and brake pedals. Inspection laws and regulations may also need to be amended to include new requirements, such as mechanisms for disengaging a level 3–5 C/ADS-equipped vehicle, to ensure the safety of these vehicles on state roadways, and for any aftermarket C/ADS technologies applied to a vehicle. Note that, based on our 15-state review, no issues were found with auto emission regulations or laws.

In terms of potential modifications to current inspection-related laws, stakeholders noted that:

<table>
<thead>
<tr>
<th>RECOMMENDATION</th>
<th>HARMONIZATION RECOMMENDED?</th>
<th>CONSUMER C/ADS APPLICATION AFFECTED FIRST</th>
<th>MEANS OF ADDRESSING</th>
</tr>
</thead>
<tbody>
<tr>
<td>UNFAIR CRIMINAL AND CIVIL SANCTIONS ON USERS (REASONABLE ARTICULABLE SUSPICION)</td>
<td>Amend statutes governing criminal and civil liability to leave open the possibility that when properly engaged, the ADS in a level 3–5 C/ADS-equipped vehicle could also be responsible in whole or in part for a resulting violation.</td>
<td>Useful but not essential</td>
<td>C/ADS-equipped passenger vehicles (later) and A-MaaS (now)</td>
</tr>
<tr>
<td>CRASH REPORTING AND RENDERING AID</td>
<td>Consider the need for modifications to “rendering aid” statutes for level 4–5 C/ADS-equipped vehicles.</td>
<td>No harmonization recommended</td>
<td></td>
</tr>
<tr>
<td>VEHICLE REQUIREMENTS</td>
<td>Consider culling obscure requirements that reference specific items (e.g. use “steering assemblies” rather than “wheels” and “braking systems” rather than “pedals”).</td>
<td>Harmonization recommended</td>
<td>C/ADS-equipped passenger vehicles and A-MaaS</td>
</tr>
</tbody>
</table>
Software components will need to be included if they affect the vehicle’s functionality (Figure 15);

Frequency and testing standards for C/ADSs should be established;

A federal database tracking automation level and aftermarket C/ADSs may be required;

Electronic readings and onboard diagnostics could be used to check specific safety features and available system updates associated with the C/ADS instead of periodic motor vehicle safety inspections or checks (designed to uncover mechanical defects).

**Figure 15. Stakeholder opinions on software update checks by inspection stations.**

**Prioritization and Harmonization Recommendations**

**Prioritization Recommendation:** Modify agency inspection legislation/regulations to accommodate the new technological features of C/ADSs.

**Harmonization Recommended:** No. Not currently harmonized at the state level; no specific reason to harmonize for C/ADS

**Long-Term Recommendation 2: Consumer Protection (i.e., Lemon Laws)**

**Prioritization Reasoning**

States should consider needed modifications to lemon laws. These laws, originally designed to protect consumers, may not be sufficient to ensure adequate protection from C/ADS product defects. For states that have adopted these laws, some modifications may be necessary to account for the fact that problems with the programming or automation may not be evident over the relatively short period during which manufacturers are legally held responsible for making repairs.

**Harmonization Reasoning**

As states begin to consider their lemon laws, best practice language may be useful in helping states to account for new technologies in order to ensure adequate consumer protection from product defects.
Prioritization and Harmonization Recommendations

**Prioritization Recommendation:** Modify lemon laws to account for new C/ADS technologies to ensure adequate consumer protection from product defects.

**Harmonization Recommended:** Useful, but not essential. Best practice language

**Consumer C/ADS application(s) affected first:** C/ADS-equipped passenger vehicles and A-MaaS

### Long-Term Recommendation 3: Occupant Safety and Protection

**Prioritization Reasoning**

Occupant safety requirements may need to be revised to take full advantage of C/ADS sensor capabilities (e.g., sensing the weight of each passenger to determine appropriate safety restraint use; disengaging when belts are not in place so that the vehicle will not operate in conflict with safety requirements laws). Currently, at least child restraint requirements (i.e., the age of a child determines the required restraint) may not be programmable in a C/ADS. However, the same or improved protections for occupants may be accomplished by alternative sensory-based requirements (e.g., passenger weight determines restraint type). Legal responsibility of drivers for meeting occupant safety provisions for level 4–5 C/ADS-equipped vehicles may also need to be assessed to determine contributory negligence provisions within revised tort laws.

**Prioritization and Harmonization Recommendations**

**Prioritization Recommendation:** Revise occupant safety requirements to take full advantage of C/ADS sensory capabilities (e.g., seatbelts and child restraints).

**Harmonization Recommended:** No. Not currently harmonized at the state level; no specific reason to harmonize for C/ADS

### Long-Term Priority Modification Recommendation Summary

In summary, the following state motor vehicle code provisions are suggested for modifications in the long-term (Table 10). Note, items below are not ordered in chronological manner.
### Table 10. Long-Term Prioritization and Harmonization Modification Recommendations

<table>
<thead>
<tr>
<th>RECOMMENDATION</th>
<th>HARMONIZATION RECOMMENDED?</th>
<th>CONSUMER C/ADS APPLICATION AFFECTED FIRST</th>
<th>MEANS OF ADDRESSING</th>
</tr>
</thead>
<tbody>
<tr>
<td>VEHICLE INSPECTION</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Modify agency inspection legislation/regulations to accommodate the new technological features of C/ADS.</td>
<td>No harmonization recommended</td>
<td></td>
<td>Not currently harmonized at the state level; no specific reason to harmonize for C/ADS</td>
</tr>
<tr>
<td>CONSUMER PROTECTION LAWS</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Modify lemon laws to account for new driving automation system-related technologies to ensure adequate consumer protection from product defects.</td>
<td>Useful but not essential</td>
<td></td>
<td>Best practice language</td>
</tr>
<tr>
<td>OCCUPANT SAFETY AND PROTECTION</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Revise occupant safety requirements to take full advantage of driving automation system-equipped vehicles' sensory capabilities (e.g., seatbelts and child boosters).</td>
<td>No harmonization recommended</td>
<td></td>
<td>Not currently harmonized at the state level; no specific reason to harmonize for C/ADS</td>
</tr>
</tbody>
</table>

### 5.4 Complex Interplay of Deployment Transition and Interoperability

Over time, the composition of the vehicle fleet will shift from almost entirely human operated vehicles to almost entirely C/ADS-equipped vehicles. The pace of this evolution is difficult to predict, but the timeline envisioned in this study sees this transition occurring over the next 30 years, with level 1 vehicles predominating now and level 5 C/ADS-equipped vehicles perhaps beginning to dominate by the end of the 30-year period or just beyond.

In this report, we consider the implications of the interoperability issues that this mix of vehicles will create for state motor vehicle codes. It could be argued that state motor vehicle codes should evolve apace with the evolving vehicle fleet. However, this approach would inevitably cause lags between the emergence of C/ADS-related issues and appropriate state motor vehicle code changes. A better approach is the application of research such as this, further study of the impact of C/ADSs on various jurisdictions, and the timely enactment of comprehensive legislative schemes to systematically address complex issues as they emerge.
Oliver Wendell Holmes famously observed that "the life of the law has not been logic: it has been experience" (Holmes, 2009, p.1). But the body of experience and case law related to C/ADSs will develop more smoothly if logical, comprehensive legislative schemes are in place from the outset. Absent such schemes, case law will develop haphazardly, driven by narrow factual situations and political concerns. As a practical matter, this will impede the implementation of C/ADSs and delay the realization of their ultimate benefits.

The demands imposed upon a state motor vehicle code by a 10% C/ADS-equipped vehicle market penetration rate versus an 80% market penetration rate are not appreciably different. A comprehensive state policy and legislative approach is needed in either scenario. Therefore, the priorities outlined in this Assessment should be considered regardless of the anticipated penetration rate.

In terms of priorities, the progression of varying levels of C/ADS fleets are not expected to be linear. As noted in the timeline, level 5 C/ADS-equipped A-MaaS vehicles will be sharing the road with level 2 passenger vehicles and level 1 C/ADS-equipped truck platoons. Given this scenario, in the event of a crash involving a level 1 platoon vehicle, a level 2 passenger vehicle, a level 4 C/ADS-equipped vehicle, and a conventional vehicle, ALL laws relating to ALL vehicles would need to be on the books.

States recognize that there will likely be decades of transition from conventional vehicles to level 4–5 C/ADS-equipped vehicles. Accordingly, planning and designing for mixed environments is essential. From a DOT perspective, this effort will require rethinking planning processes. The same will hold true for DMVs and law enforcement.

### 5.5 Prioritization and Harmonization Conclusions

States need to begin modifying their laws and regulations now, at least in basic areas such as definitions, and in rapidly advancing areas. However, while moving forward is important, any action should also be tempered by a state recognition that some issues are not yet clear. That lack of clarity is primarily rooted in three key issues:

1. As of this writing, the federal direction for C/ADS-equipped vehicles oversight has yet to be set and it is unknown what federal preemption will include and what actions Congress will take.

2. The timeline for deployment of different levels of C/ADS-equipped vehicles is also unknown, but is not expected to be linear.

3. Many states are waiting for model laws before taking action, but that effort (with the exception of AAMVA’s continued work on best practices) is not imminent and has been met with concerns from the motor vehicle community.

Despite these issues, enough states are now moving ahead to provide good law and regulation examples to consider. Drawing on these states’ laws and regulations as examples, and using the checklist and timetable of the top expected legal and regulatory modifications included within this chapter, state agencies, lawmakers, and other state stakeholders can begin to prioritize what modifications will be most needed in their states and plan accordingly.

The eventual deployment of C/ADS-equipped vehicles will require a regulatory structure that can cross state lines as easily as these vehicles will. These recommended changes and harmonization efforts are based on their urgency, as well as their necessity for the deployment of each consumer C/ADS application. As outlined, many of the most urgent recommendations for harmonization relate to elements of state motor vehicle codes that define key terms and their implications. For example, who is a “driver”
or an “operator” of a motor vehicle and what exactly does it mean to “drive” or “operate” the vehicle on public roads?

Similarly, states are encouraged to harmonize changes that address previously basic scenarios. Situations where a vehicle is left unattended will soon take on a very different meaning when A-MaaS services become available, as these vehicles must be able to operate without any human passengers or operators present between trips. Additionally, for truck platoons to properly operate, issues related to minimum following distances and other core aspects will need to be addressed and harmonized so that the full benefits of this technology can be realized.

Meanwhile, states should not underestimate the challenges associated with any harmonization effort, and as such, should not expend energy or time harmonizing their motor vehicle codes for matters that don’t require uniformity. We advise against harmonization for recommended changes related to such issues as distracted driving, driving under the influence, privacy protections, lemon laws, and occupant protection devices, among others. These recommended changes, while no less important, simply fail to rise to the level of requiring states harmonization, as many are not currently harmonized for level 0 vehicles, to little or no ill effect.
Chapter 6.

Barriers to Legislative and Regulatory Modifications

There may be some barriers to modifying legislation and regulations. Recognizing barriers and the role of different entities in addressing them will be helpful in the modification process. Among those playing a role are federal and state governments, technology companies, suppliers and OEMs (and many other stakeholders), consumers, state legislatures, and researchers. Based on input from the legal and regulatory needs assessment (Serian et al., 2017) and further discussions conducted with stakeholders, the following barriers were identified and suggestions for addressing them provided.

6.1 Lagging Legislative Action

A lagging legislative timeframe and a traditional approach to law change in a non-traditional environment is one of the greatest barriers to advancing C/ADS deployment laws. Forming advisory committees, especially committees that include legislative representation, begins to address this barrier foundationally.

6.2 A Quick-Fix Approach

An effort to “fit” C/ADS related laws into current statutes without a comprehensive review and understanding of state motor vehicle codes may result in provisions that become barriers as the technology advances. An additional issue in this area is a lack of legislative understanding of C/ADS technology. Continual legislative education, especially with legislative leaders, is important.

6.3 Lack of a Model State Policy or Minimum Best Practices Guidance

This is the first time in many years that a uniform federal and state approach has been necessary outside of federally governed programs. As noted, some states are already beginning to modify or add laws. If federal and state entities do not work together, diverse and varying underlying basic definitions will create problems that will worsen over time. Associations such as AAMVA and AASHTO will be the most likely entities to work with their members in addressing this barrier.

6.4 A Focus Only on Testing

A barrier for state legislative changes, especially states that have not been actively involved with C/ADS legislation, is a sole focus on testing laws and regulations. With a body of references now available and with NHTSA’s guidelines, states should focus on both testing AND deployment.

6.5 Lack of Federal Clarifications

A lack of clarifications from the federal government and Congress is a huge barrier for states as they determine what deployment laws and regulations should look like. Manufacturers continue to determine what direction C/ADS deployment takes. And there is even a question as to whether the federal government or NHTSA has the required technological expertise to regulate C/ADSs. There is no way for states to hurdle this barrier on their own, but they can work closely with their congressional delegations, the NGA, AAMVA, and AASHTO to help accelerate clarity.
6.6 Lack of or Delayed State-led C/ADS Working Group

The lack of any state working group is a barrier to even beginning to assess what laws or regulations need to be modified. Implementing a working group is one of the overarching recommendations of this Assessment, and one way to address this barrier.

6.7 Overstated Automation Capabilities

There is some concern that manufacturers are overstating C/ADS capabilities. This, coupled with a lack of state technical support or expertise, is a barrier to willingness to move forward with modifications to laws and regulations. Approaching research institutions as well as external resources with expertise in C/ADSs can help states address this barrier in the short term. Building up state resources for this generation of transportation is a desirable longer-term approach.

6.8 Lack of Best Practices

Perhaps the greatest barrier to legislative and regulatory modifications is the lack of model guidelines, minimum guidelines, best practices, or model language for states. States considering modifications can use existing legislative modifications (as implemented by those states presented within as Category 1 and 2 states) as an overall baseline for advancing their own legislative language. Additionally, continued consultation with AAMVA is recommended.
Chapter 7.

Conclusions

In this Prioritization Assessment and Harmonization Analysis, we have identified the areas that merit the most attention in the short-, mid-, and long-terms as C/ADSs are deployed in all domains. The eventual deployment of C/ADSs will require a regulatory structure that will work across state lines. In some cases, this will require that states work together to harmonize their motor vehicle codes in advance to enable the operation of this new technology as it develops.

Addressing these recommended modifications and harmonization needs will take coordination with state legislatures, sister state agencies, and a close alliance with industry. States are encouraged to use the priorities outlined in this Assessment to put a strategic framework in place to assess, engage, and act as they consider modifications to state motor vehicle codes. Further, the role of AAMVA and AASHTO in this effort cannot be overemphasized. AAMVA’s expert staff and its Automated Vehicles Best Practices Working Group and Law Enforcement Standing Committee, consisting of DMV and law enforcement practitioners on the front lines, are valuable resources, and AAMVA continues to be a leader in the area of C/ADS deployment. Similarly, AASHTO staff is a valuable resource for DOT administrators.

The prioritization and harmonization summary tables presented in Chapter 5 illustrate that 2018–2020 is an important timeframe for states to begin legislation and regulation changes (Table 8, Table 9, and Table 10). States can choose to make these modifications earlier, but should also closely monitor the marketplace and any federal oversight direction. Just as importantly, any modifications suggested should be in a form that allows for flexible updating and ease of change. Regulations (unless they can be completed rapidly) are most likely not the best choice for modifications.

7.1 Next Steps

Figure 16 highlights the input that informed this Prioritization Assessment and Harmonization Analysis. These inputs will lead to additional practical components of the Autonomous Vehicle Action Plan (AVAP) that will provide states with additional resources.
Figure 16. Contributing factors to the AVAP.
Acronyms and Definitions

AAMVA American Association of Motor Vehicle Administrators
AASHTO American Association of State Highway and Transportation Officials
ADS automated driving system
A-MaaS automation mobility as a service
C/ADS connected and automated driving system
CDL commercial driver’s license
CDLIS Commercial Driver’s License Information System
CFR code of federal regulations
CMV commercial motor vehicle
CVSA Commercial Vehicle Safety Alliance
DDT dynamic driving task
DMV Department of Motor Vehicles
DOT Department of Transportation
FHWA Federal Highway Administration
FMCSA Federal Motor Carrier Safety Administration
FMVSS Federal Motor Vehicle Safety Standards
MUTCD Manual on Uniform Traffic Control Devices
NGA National Governors Association
NCHRP National Cooperative Highway Research Program
NHTSA National Highway Traffic Safety Administration
ODD operational design domains
PII personally identifiable information
SELF DRIVE Act Safely Ensuring Lives Future Deployment and Research in Vehicle Evolution Act
UVC Uniform Vehicle Code
V2I vehicle-to-infrastructure
V2V vehicle-to-vehicle
V2X vehicle-to-vehicle and vehicle-to-infrastructure (collectively)
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C/ADS Legal and Regulatory Prioritization and Harmonization Assessment


U.S. Const. amend. X.


