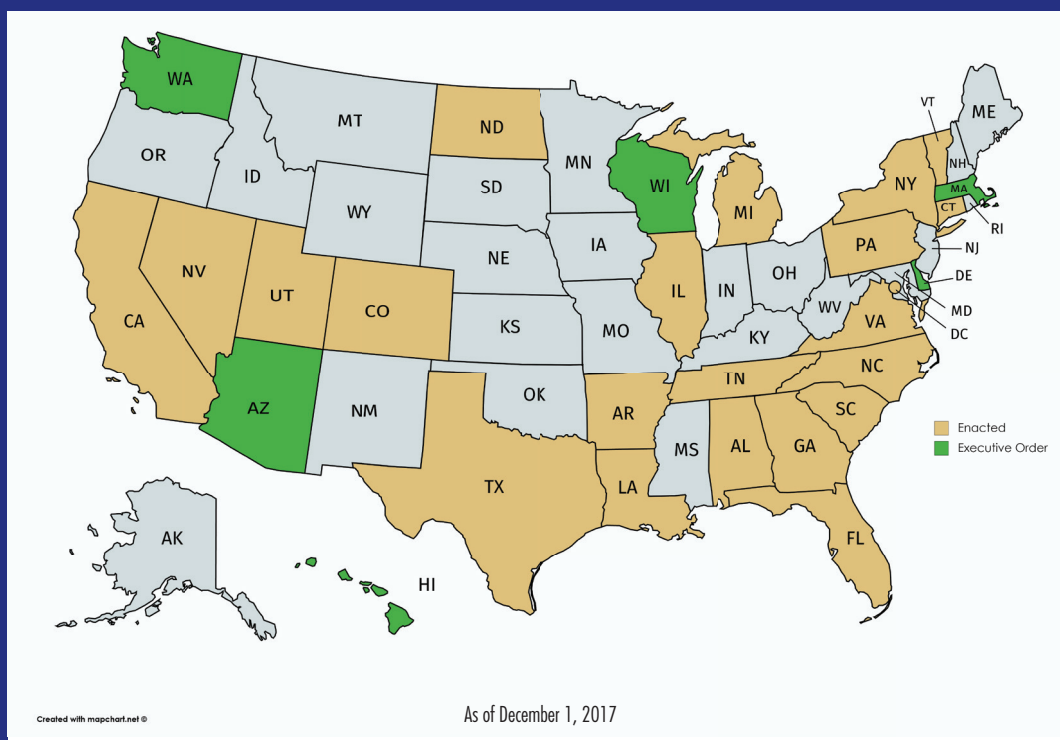


JOINT TRANSPORTATION RESEARCH PROGRAM

INDIANA DEPARTMENT OF TRANSPORTATION
AND PURDUE UNIVERSITY



Synthesis of Automated Vehicle Legislation



Sarah M. Hubbard

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16. Abstract <p>This report provides a synthesis of issues addressed by state legislation regarding automated vehicles (AV); AV technologies are rapidly evolving and many states have developed legislation to govern AV testing and deployment and to assure safety on public roads. Topics include license and registration, operator requirements, insurance and liability, infrastructure, vehicle testing and operations, commercial vehicle operations and privacy.</p> <p>States are interested in supporting AV because the expected benefits include increased safety, increased capacity, and decreased congestion. Other expected benefits include increased productivity due to hands-free travel and increased mobility for people unable to drive themselves. The projected economic impact of AV is significant, with an estimated market of \$7 trillion by 2050. Although speculative, this value indicates the dramatic impact that AV may have on the future of transportation. The benefits of AV may be significant, however, there are also potential challenges, including the potential for increased costs, liability issues, licensing issues, security concerns, privacy considerations, and cybersecurity issues, as well as job losses in the transportation sector.</p> <p>Legislative responses to this technology have varied significantly, depending on the state. Currently nineteen states and the District of Columbia have passed legislation related to AV, and four states have executive orders. Even if federal AV legislation is passed, there will still be an important role for states regarding AV licensure, registration, insurance, traffic laws, enforcement, infrastructure and emergency response. The objective of this research is to identify and synthesize current state legislation related to AV. The results provide important information as agencies and decision makers develop strategic plans for AV activities at every level.</p>		13. Type of Report and Period Covered Final Report	
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EXECUTIVE SUMMARY

SYNTHESIS OF AUTOMATED VEHICLE LEGISLATION

Introduction

Automated vehicle (AV) technologies are rapidly evolving, and many states have developed legislation to support AV testing and deployment and to ensure safety on public roads. This research provides a synthesis of issues addressed by state legislation and a discussion of issues related to AV regulation.

States are interested in supporting AV because the expected benefits include increased safety, increased capacity, and decreased congestion. Other expected benefits include increased productivity due to hands-free travel and increased mobility for people unable to drive themselves. The projected economic impact of AV is significant, with an estimated market of \$7 trillion by 2050. Although speculative, this value indicates the dramatic impact that AV may have on the future of transportation. The benefits of AV may be significant, but there are also challenges, including the potential for increased costs, liability issues, licensing issues, security concerns, privacy considerations, and cybersecurity issues, as well as job losses in the transportation sector.

Findings

Legislative responses to this technology have varied significantly, depending on the state. Currently, twenty states and the District of Columbia have passed legislation related to AV, and four states have executive orders, as shown in Figure 3.1 of the report. The framework for AV is still evolving at both the national and state levels. At the national level, the National Highway Traffic Safety Administration (NHTSA) published the Federal Automated Vehicles Policy (FAVP) in 2016. This document provides guidance rather than regulations, and sets forth a standard framework for levels of autonomy, as shown in Table 2.1 of the report, as well as guidance on vehicle performance, a model state policy, and current and future regulatory tools.

The levels of autonomy shown in Table 2.1 provide common terminology for agencies and industry. Level 0 (L0) reflects no automation and level 5 (L5) reflects full automation. As automation increases, the responsibility for operation transitions from the human operator to the AV. The primary distinction between conventional vehicle operation (L0, L1, and L2) and a highly automated vehicle (HAV; L3, L4, and L5) is the responsibility for monitoring the environment. (This document uses the term HAV for L3, L4 and L5 per the FAVP convention; HAV is not an acronym for “high automation,” which is the name for level 4 as referenced by SAE.)

The third component of the FAVP is the model state policy, which clarifies federal and state responsibilities with respect to AV and supports seamless operation from one state to another. According to the FAVP, state AV responsibilities include driver licensing and vehicle registration, traffic laws and enforcement, safety inspections, and motor vehicle insurance and liability. State legislation often addresses licensing and registration, and insurance and liability, but has less commonly addressed traffic laws and enforcement or safety inspections. Nevada was the first state to enact legislation in 2011; this legislation provided definitions, authorized operation, and directed the Department of Motor Vehicles (DMV) to develop rules for licensure and operation. Subsequent legislation for different states has varied significantly.

In some states, legislation is minimal and may focus on the legal definition of AV and related concepts. In other states, test programs are authorized, operational limits are placed on AV, and/or funding for AV activities are allocated.

States that were early adopters of legislation have often passed new legislation to clarify, expand, or modify the original framework for AV. This reflects the changing context for AV testing and operation. The need for flexibility can also be addressed through sunset provisions in legislation or through legislation that delegates responsibilities to state agencies for program development and oversight. State legislation and executive orders were reviewed to determine whether they addressed the following topic areas, as shown in Table 2.2 of the report.

1. **Definitions.** Definitions are one of the most basic components of legislation and may stand alone or be part of more comprehensive legislation.
2. **Study request.** Existing agencies may be tasked with studies, or committees of stakeholders may be responsible for studies of broad issues related to AV or specific functions; studies may require a single report to the legislature or have annual reporting requirements. This is a topic addressed by all the executive orders and by most of the enacted legislation.
3. **Licensing and registration.** Driver licensing and vehicle registration programs are commonly addressed in legislation, reflecting traditional state responsibilities.
4. **Insurance and liability.** States have well-developed criteria for insurance and liability, although minimum requirements and allowable programs (e.g., no-fault insurance) may vary from state to state.
5. **Vehicle inspection requirements.** Some states elect to conduct vehicle inspections to ensure minimum safety or emissions standards are met.
6. **Operator requirements.** The requirements for operators vary from state to state and in some cases for different levels of automation.
7. **Infrastructure.** Infrastructure to support AV may include communications or signal systems equipment and connected vehicle (CV) technologies, as well as traditional components such as lane markings and signs.
8. **Vehicle testing on public roads.** The FAVP defines testing as the deployment of HAV by manufacturers or researchers to evaluate and analyze operations.
9. **Operation on public roads.** The FAVP defines operation as the use of HAV by members of the public who are not manufacturers or researchers.
10. **Commercial vehicle operation (CVO).** CVO may have additional requirements such as commercial driver licensing, vehicle inspections, and permitting. Recent legislation in a number of states has addressed vehicle platooning targeted specifically to the CVO market.
11. **Privacy.** Privacy concerns are an important consideration and include vehicle data that conveys vehicle location, as well as operational characteristics, particularly during or preceding an accident.

Implementation

State laws may be intended to facilitate AV and associated economic development; however, state legislation is just one of many factors that affects AV activity. In many cases, legislation may not be necessary for AV to operate legally, and it may not be a catalyst to spur AV activities. As noted by one technology firm, “It is the lack of regulations that really makes Arizona attractive. In the

U.S., if it isn't illegal, it's legal. Arizona hasn't passed laws on the subject—that actually makes it easier to operate there.”

In addition to legislation, some states have developed partnerships with industry and research institutions, investments in infrastructure, and formal requests for proposals for AV partnerships to foster AV activities. States have taken a variety of approaches to AV legislation, and similar legislation has had different outcomes

in terms of AV activities. Even if federal legislation is passed, it is expected that there will still be an important role for states for AV licensure, registration, insurance, traffic laws, enforcement, infrastructure, and emergency response. The review of topics addressed in current state legislation provides a frame of reference for Indiana decision makers to consider as they develop strategic plans for AV in Indiana.

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1. INTRODUCTION AND MOTIVATION

Numerous states have taken the initiative to enact legislation to assure a safe and well-defined framework for autonomous vehicle (AV) technologies, which are rapidly evolving and are expected to provide many benefits including increased safety, increased capacity, and decreased congestion. Other expected benefits include increased productivity due to hands-free travel and increased mobility for people unable to drive themselves. AV technologies are considered an important tool to address the 40,000 deaths from motor vehicle crashes in 2016 (National Safety Council, 2017). Other expected benefits include increased productivity due to hands-free travel and increased mobility for people who are not able to drive without vehicle automation. The projected economic impact of AV is significant, with projections as high as \$1.2 trillion or \$3,800 per person per year (Clements & Kockelman, 2017), and an estimated market of \$7 trillion by 2050 (Morris, 2017). Although speculative, these values indicate the dramatic impact that AV may have on the future of transportation. The benefits of AV may be significant; however, there are also potential challenges, including increased costs, liability issues, licensing issues, security concerns, and privacy considerations (Fagnant & Kockelman, 2015), as well as job losses in the transportation sector.

Legislative responses to this technology have varied significantly, depending on the state. Currently twenty states and the District of Columbia have passed legislation related to AV, and four states have executive orders. The objective of this research is to identify and synthesize issues addressed by current state legislation related to AV. The results of this research will provide important information for decision makers as they develop a strategic plan for AV activities in Indiana.

2. BACKGROUND

The legislative framework for AV is still evolving at both the national and state level. At the national level, the National Highway Traffic Safety Administration (NHTSA) published a Federal Automated Vehicles Policy (FAVP) (NHTSA, 2016). This document provides guidance rather than regulations, and sets forth a standard framework for many aspects, include levels of autonomy, as shown in Table 2.1, guidance for vehicle performance, a model state policy (in Appendix A), and a discussion of current and future regulatory tools for AV.

The levels of autonomy shown in Table 2.1 are based on definitions provided by SAE International in J3016 (SAE International, 2014), and provide a common terminology that is consistent with industry. Level 0 (L0) reflects no automation and level 5 (L5) reflects full automation. As automation increases, the responsibility for operation transitions from the human operator to the AV. The primary distinction between conventional vehicle operation (L0, L1 and L2) and a highly automated vehicle (HAV, which includes L3, L4 and L5)

is the responsibility for monitoring the environment.¹ It is likely that L4, which would include autonomous operation on a freeway during good weather, may be realized before L5, which would be autonomous operation on any public street in any weather condition.

Level 5 would include the capability to safely operate in urban areas with a wide variety of users, including pedestrians, cyclists, and delivery trucks. Level 5 would also include automated operation through complex geometries, such as one-way street networks, toll plazas, and roundabouts. Level 5 would also adapt to local operating regulations that may vary depending on jurisdiction and time of day, including local speed limits and school zones, and turn prohibitions during the peak hour. Some companies plan to skip L3 altogether, due to concerns with driver vigilance and potential challenges with human drivers being able to respond quickly and appropriately when needed (Naughton, 2017).

The second part of the FAVP is guidance for vehicle performance, intended to assure safety during testing and provide data that may be useful for NHTSA during the development of future regulations. Vehicle safety standards are currently the responsibility of the federal government, and all vehicles sold in the US must meet Federal Motor Vehicle Safety Standards (FMVSS). The FAVP proposes that the federal government maintain this responsibility, and outlines the voluntary 15-point safety assessment shown in Table 2.2 as important factors that manufacturers should consider to assure safety during testing and deployment. Manufacturers must obtain an exemption to FMVSS for testing purposes in some cases. For example, a vehicle without a steering wheel, accelerator or brake pedal would require an exemption since it does not meet the FMVSS. Currently, the NHTSA can grant exemptions for up to 2,500 vehicles. New federal legislation may increase this limit to 100,000 (Eno, 2017), which manufacturers claim would facilitate more rapid innovation since it would allow data to be collected more quickly. Similar to the FMVSS, commercial vehicles that weigh more than 10,000 pounds, support interstate commerce or transport passengers or hazardous material, must meet Federal Motor Carrier Safety Regulations (FMCSR).

The third component of the FAVP is the model state policy, which further clarifies federal and state responsibilities with respect to AV and is intended to provide seamless operation of AV from one state to another. In addition to safety standards for vehicles and equipment, the federal government must enforce compliance, is responsible for vehicle recalls, communicate with the public regarding safety issues, and provide guidance to support national safety goals. According to the FAVP, state responsibilities for AV reflect current state activities, including:

- Driver licensing and vehicle registration,
- Traffic laws and enforcement,

¹This document uses the term HAV for L3, L4 and L5 per the FAVP convention; HAV is not an acronym for “high automation,” which is the name for level 4 as referenced by SAE.

- Safety inspections,
- Motor vehicle insurance and liability.

If states wish to regulate the testing and operation of AV, the federal guidance provides a model state policy to support these activities, including administrative

structures and processes for regulation of testing and deployment on public roads, registration of vehicles and drivers, law enforcement and liability and insurance considerations. A summary of the model state act is provided in Appendix A.

TABLE 2.1
SAE International Definitions for Levels of Autonomy (NHTSA, 2016)

Responsible for monitoring environment	Level	Description
Human operator	0	Human driver does everything
	1	Limited assist with some functions (e.g., backup warning beep)
	2	Automation can conduct some parts of driving task, human monitors and controls other tasks (e.g., cruise control)
Automation (HAV = highly automated vehicle)	3	Automation can conduct some parts of task and monitor driving environment but human ready to take back control
	4	Automation can conduct driving task and monitor driving environment but only in certain environments and under certain conditions
	5	Automation performs all tasks under all conditions

TABLE 2.2
15-Point Vehicle Safety Assessment and Key Concepts Identified (NHTSA, 2016)

1. Data Recording and Sharing	Process should be documented and crash data should be available to NHTSA for crashes that result in fatalities or injuries, or damage the vehicle such that it can't be driven.
2. Privacy	Consumer privacy should be ensured and individual data should not be identifiable.
3. System Safety	Process should include hazard analysis and safety risk assessment for HAV, overall vehicle design, and broader transportation system. There should be industry sharing.
4. Vehicle Cybersecurity	
5. Human Machine Interface	Design must consider need to convey information to driver as well as pedestrians and other drivers/vehicles.
6. Crashworthiness	Design must provide occupant protection (and potentially enhanced protection based on sensor information) as well as compatibility with unoccupied automated vehicles.
7. Consumer Education and Training	Manufacturers must develop information for employees, dealers, distributors and consumers about system, operational intent, capabilities and limitations, and emergency operation and engagement/disengagement methods, etc.
8. Registration and Certification	Manufacturers must submit information about HAV components to NHTSA and vehicle must convey system capabilities and limitations. Information must be updated to reflect changes due to software updates or equipment modifications.
9. Post-Crash Behavior	Process should be documented for assessment after a crash and vehicle cannot operate in HAV mode until system and sensors are validated.
10. Federal, State and Local Laws	Plans for programming to assure compliance with all applicable traffic laws must be documented.
11. Ethical Considerations	There must be transparency regarding decision rules and programming to address conflict dilemmas on the road that affect objectives related to safety, mobility and legality.
Automation Functions	
12. Operational Design Domain (ODD)	Manufacturer must specify how and where the HAV system can operate, including roadway type, geographic area, speed, and environmental conditions.
13. Object and Event Detection and Response (OEDR)	There must be a documented process for assessment and validation of the capabilities of the HAV system, including the reception and response functions.
14. Fall Back (Minimal Risk Condition)	The response upon failure must be documented, and may include transition of operation to a human driver or bringing the vehicle to a safe stop outside the traffic lanes.
15. Validation Methods	Performance of HAV components must be demonstrated with testing, validation, and verification. This may include testing via simulation, test track and on public roads.

In addition to the FAVP guidelines, federal lawmakers have proposed legislation to address automated vehicles. In June, 2017, 14 bills were drafted; these provide additional authority to NHTSA, would allow more vehicle exemptions from the FMVSS (Marshall, 2017), and would also prevent states from setting their own rules for AV, ensuring continuity across state lines, and prevent NHTSA from preapproving vehicle technologies, assuring that legislation remains technology neutral (Shepardson, 2017).

3. AUTOMATED VEHICLE STATE LEGISLATION

A map of the states that have enacted legislation or executive orders related to AV technology is shown in Figure 3.1. Twenty states and the District of Columbia have enacted legislation and four governors have issued executive orders, as of July 15, 2017 (National Council of State Legislatures (NCSL), 2017).

Nevada was the first state to enact legislation in 2011; this legislation provided definitions, authorized operation, and directed the Department of Motor Vehicles (DMV) to develop rules for licensure and operation (AB 511, 2011). Subsequent legislation for different states has varied significantly. In some states, legislation is minimal and may focus on the legal definition of AV and related concepts. In other states, test programs are authorized, operational limits are placed on AV, and/or funding for AV activities are allocated.

States that were early adopters of legislation have often passed new legislation to clarify, expand or modify the original framework for AV. This reflects the changing context for AV testing and operation. The need for flexibility can also be addressed through sunset provisions in legislation or through legislation that delegates responsibilities to state agencies for program development and oversight.

Legislation and its impact varies significantly. Current state legislation and executive orders were reviewed and categorized for discussion regarding the following topic areas shown in Table 3.1²:

1. **Definitions.** Definitions are one of the most basic components of legislation and may stand alone or be part of more comprehensive legislation.
2. **Study request.** Existing agencies may be tasked with studies, or committees of stakeholders may be responsible for studies of broad issues related to AV or specific functions; studies may require a single report to the legislature or have annual reporting requirements.
3. **Licensing and registration.** Driver licensing and vehicle registration programs are addressed in many of the laws governing AV.
4. **Insurance and liability.** States have well developed criteria for insurance and liability, although minimum requirements and allowable programs (e.g., no fault insurance) may vary from state to state.

²These topic areas are used by the National Congress of State Legislatures (NCSL, 2017), however, the assessment in this document is does not align with the search results by topic areas using the NCSL website since this discussion is more detailed.

5. **Vehicle inspection requirements.** Some states elect to conduct vehicle inspections to assure minimum safety or emissions standards are met.
6. **Operator requirements.** The requirements for operators vary significantly in different states and even within a state for different levels of automation.
7. **Infrastructure.** Infrastructure to support AV may include communications or signal systems equipment, connected vehicle (CV) technologies, and traditional components such as lane markings and signs.
8. **Vehicle testing on public roads.** The FAVP defines testing as the deployment of HAV by manufacturers or researchers to evaluate and analyze operations (NHTSA, 2016).
9. **Operation on public roads.** The FAVP defines operation as the use of HAV by members of the public who are not manufacturers or researchers (NHTSA, 2016).
10. **Commercial vehicle operation (CVO).** CVO may have additional requirements such as commercial driver licensing, vehicle inspections and permitting. In some cases, technologies such as vehicle platooning may be targeted specifically to the CVO market.
11. **Privacy.** Privacy concerns are an important consideration, and include vehicle data that conveys vehicle location, as well as operational characteristics, particularly during or preceding an accident.

Each of these areas as well as other considerations, including cyber security, local and federal laws, and the dynamic framework for AV, are addressed in more detail in the following sections. Generally, licensing and registration, insurance and liability, vehicle inspection requirements and operator requirements address areas that are already governed by state legislation and typically have a well-developed program and process in place.

Legislation that explicitly permits AV may serve as one catalyst for AV activities in a state. Other catalysts may include partnerships with industry, universities and research centers. Some legal scholars have suggested that state legislation is not needed for AV to operate legally because AV are not prohibited (Smith, 2014). State laws that imply or require a driver could be interpreted to apply to a nonhuman driver in the case of an AV. Other scholars take a more conservative view and suggest that enabling legislation is appropriate (Kohler & Colbert-Taylor, 2014).

In any case, AV have operated in numerous states without explicit AV legislation. Testing and demonstrations include a blind man riding in a self-driving Google car in Austin, Texas, in December, 2016, (Halsey & Laris, 2016) and an Uber truck delivery in Colorado in October, 2016, (Newcomer & Webb, 2016); both of these demonstration predate the AV state legislation enacted in Texas and Colorado in June, 2017.

Nonetheless, many states have chosen to establish AV legislation to set a framework for AV activities, encourage AV development, provide assurance that private sector activities will not meet unexpected obstacles, and ensure public safety. A brief summary of the legislation in each state is provided in Appendix B (NCSL, 2017).

Discussion is intended to provide an overview of how topics are addressed with examples, rather than a

TABLE 3.1
Topics Addressed by State AV Legislation

State	Year	Defns	Study	License and registration	Operator requirements	Insurance and liability	Vehicle inspection	Infra-structure	Vehicle testing	Operation	CVO (incl platoons)	Privacy
Enacted legislation												
AL	2016		✓									
AR	2017	✓							✓	✓	✓	
CA	2012 2016	✓	✓	✓	✓	✓			✓	✓		✓
CO	2017	✓	✓						✓	✓		
CT	2017	✓	✓	✓	✓	✓			✓			
FL	2012 2016	✓	✓	✓	✓	✓		✓	✓	✓	✓	
GA	2017	✓		✓	✓	✓			✓	✓	✓	
LA	2016	✓										
MI	2013 2016	✓	✓	✓	✓	✓			✓	✓	✓	✓
NV	2013 2017	✓		✓	✓	✓	✓		✓	✓	✓	✓
NY	2017	✓	✓	✓	✓	✓			✓			
NC	2017	✓	✓	✓	✓	✓				✓	✓	
ND	2015 2017		✓	✓								
PA	2016							✓				
TN	2015 2016 2017	✓		✓	✓	✓			✓	✓	✓	
TX	2017	✓	✓	✓	✓	✓				✓	✓	
UT	2015 2016	✓	✓						✓		✓	
VA	2016			✓						✓		
VT	2017		✓									
DC	2012	✓			✓	✓				✓		
Executive Orders												
AZ	2015		✓	✓	✓	✓			✓	✓		
MA	2016		✓		✓	✓	✓		✓			
WA	2017		✓	✓	✓	✓			✓			
WI	2017		✓									

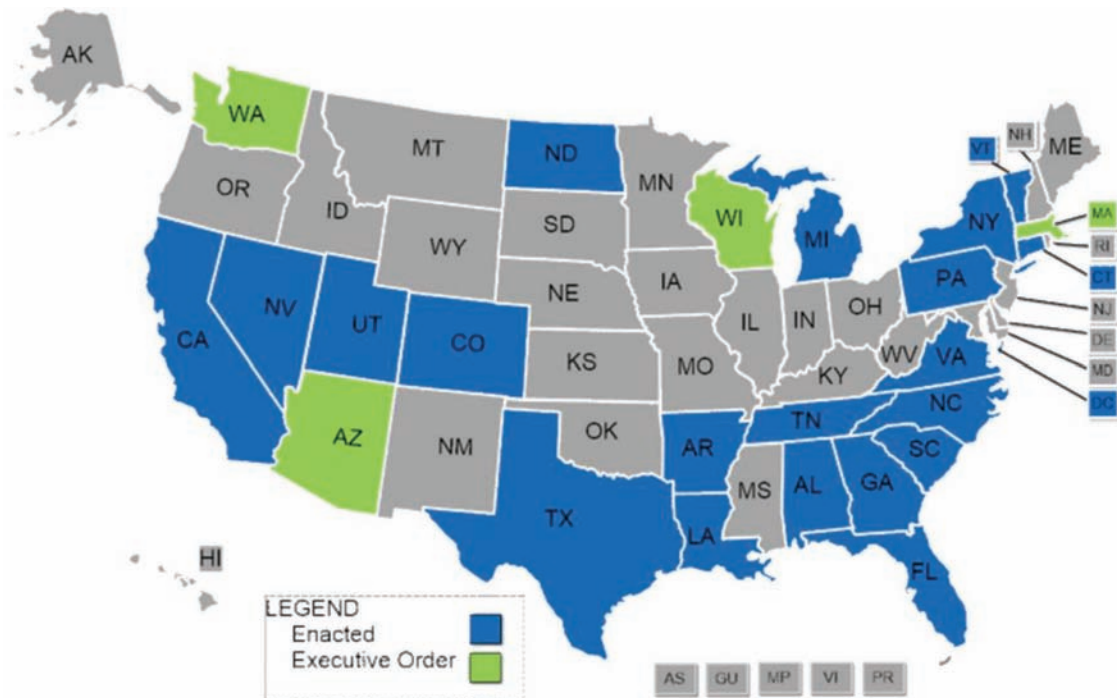


Figure 3.1 States with automated vehicle legislation (as of October 12, 2017) (NCSL, 2017).

complete inventory of every legislative component in each state. In some cases, there is overlap between topic areas; for example, often the operator requirements may overlap with the requirements for license, registration and insurance requirements.

4. DEFINITIONS

Definitions are one of the most frequently included components of legislation and may stand alone (e.g., Louisiana HB 1143, 2016), or part of more comprehensive legislation. Common terms and concepts defined include autonomous vehicle, automated driving, autonomous or automated driving system, autonomous technology, operational design domain, minimal risk condition, operator or human operator and platoon.

Legislation has defined AV terms differently as activities evolve and technologies progress. The publication of the FAVP has led to increased consistency for definitions, and many states have included references to the SAE automation levels of automation. Nevada (AB 69, 2017) specifies that AV means L3, L4 or L5. Colorado (SB 213, 2017) specifies that L0 to L3 is not addressed by the legislation, and defines an automated driving system (ADS) as HAV L4 or L5. Connecticut (SB 260, 2017) defines SAE J3016 but does not refer to levels of automation or how these levels translate to requirements in the state.

The same concept may be referred to by different names in different states. A platoon may also be called a coordinated platoon (e.g., Georgia HB 472, 2017), a driver-assistive truck platooning system (e.g., Arkansas

HB 1754, 2017, and Florida HB 7061, 2016) or a connected braking system (e.g., Texas HB 1791, 2017).

Definitions may also clarify what is excluded. Numerous states (e.g., Florida HB 7061, 2016; California SB 1298, 2012; and Tennessee SB 1561, 2016) clarify that a vehicle is not an AV due to systems that enhance safety or provide driver assistance, as long as the technologies are not capable of operating the vehicle or monitoring by the human operator. Excluded technologies typically include collision avoidance, electronic blind spot assistance, adaptive cruise control, and other L1 and L2 technologies.

Texas defines the entire dynamic driving task in terms of operational aspects (steering, braking and monitoring environment) and tactical aspects (responding to events and determining when to take action), and clarifies that it does not include strategic aspects such as the determination of destinations (SB 2205, 2017). Analogous definitions are also seen in Louisiana (HB 1143, 2016) and Connecticut (SB 260, 2017).

As technologies progress, legislation looks forward to future applications and defines new terms that may apply when there is no human driver, and when taxi or ridesharing fleets consist of AV. Michigan defines the SAVE program (SB 995, 2016), which is similar to the autonomous vehicle network company defined in Nevada (AB 69, 2017).

Definitions are important and may provide clarification, however, in some cases, the lack of a consistent, standard and shared vocabulary can present obstacles, and legislative attempts to define even basic terms such as operator and driver can be confusing (Korosec, 2016).

5. STUDY REQUEST OR COMMITTEE

Study requests and committee appointments are a common component of AV legislation. Each of the four Executive Orders appoints an AV work group (Exec. Order No. 17-02, 2017; Exec. Order No. 245, 2017; Exec. Order No. 572, 2016; Exec. Order 2015-09, 2015). In Alabama (SJR81, 2016), North Dakota (HB 1065, 2015; HB 1202, 2017), Utah (HB 373, 2015; HB 280, 2016) and Vermont (HB 494, 2016), this is the entirety of the legislation. Alabama established a joint legislative committee to study all aspects including safety and economic impacts, and report back in a year, at which point the committee would be dissolved. North Dakota's legislation requested a study of AV issues such as legislation, licensing, registration, insurance, and inspection, as well as data ownership and potential uses for the information gathered by AV.

In other states, studies, committees and reports are one component of broader legislation. Florida's 2012 legislation provided a framework AV issues and also required that state agencies submit a report regarding the need for additional regulations or legislation for safe testing and operation (HB 1207). Legislation in Florida (HB 7061, 2016) and Utah (HB 373, 2015) required a study on truck platooning. Colorado's 2017 legislation mandates that the DOT provide an annual report regarding AV testing in Colorado (SB 213, 2017).

Study requests may reflect future policy. Michigan's 2013 legislation required recommendations for legislation regarding liability (SB 169, 2013), which was later addressed by SB 663 (2016), which limited liability for original manufacturers in the case of conversion by upfitters. In 2016, Michigan also legislated (SB 995) the Michigan Council on Future Mobility within the DOT to provide recommendations for policy changes on an annual basis.

Councils or working groups to address the topic have been given a variety of names including Autonomous Vehicle Working Group (Exec. Order No. 572, 2016), Governor's Steering Committee on Autonomous and Connected Vehicle Testing and Deployment (Exec. Order No. 245, 2017), Self-Driving Vehicle Oversight Committee (Exec. Order No. 2015-09, 2015) and Fully Autonomous Vehicle Committee (North Carolina HB 469, 2017). In some cases a study group is appointed but may not have a designated name (e.g., Exec. Order No. 17-02, 2017; Vermont HB 494, 2017).

Of note is California's 2016 legislation that authorized the testing of driverless vehicles without a steering wheel, accelerator or brakes through the Contra Costa Transportation Authority pilot project. This project later became one of the ten vehicle proving grounds established by the US Department of Transportation (USDOT, 2017).

6. LICENSING AND REGISTRATION

Vehicle licensing and registration is a well-defined process for traditional motor vehicles in all states.

Licensing and registration assures that the state has necessary information about the vehicle and owner, often serves as a mechanism to confirm that the vehicle is insured, and provides a source of revenue to support roadway infrastructure. State requirements for vehicle inspections may also be integrated into the license and registration process.

The need for licensing and registration specifically for automated vehicles is addressed by legislation in numerous states. In some cases, special plates are required for AV (e.g., Michigan SB 169, 2013). In other states, such as Virginia (HB 454, 2016), AV that are being tested are issued standard plates to assure that other drivers do not change their behavior and affect testing results (Buchanan-King, 2016). In Nevada (AB 69, 2017), legislation specifies that the Department may adopt regulations that include provisions related to license plates and registration but these should not unusually impede AV testing and operation. Some state legislation states that an owner may identify the vehicle as automated (e.g., Texas SB 2205, 2017), whereas other states require registration as automated (e.g., Georgia SB 219, 2017; Tennessee SB 151, 2017).

States may reiterate the need for vehicles to be compliant with applicable federal standards and regulations for registration (e.g., Florida HB 7027, 2016), with recent legislation more likely to require compliance with standards established by the NHTSA regarding fully autonomous vehicles. These requirements may be included as part of the legislation related to registration, as well as the legislation related to operators, testing and operational requirements, as discussed in later sections.

6.1 Fees and Funding

Fees for vehicle licensing and registration are often an important source of revenue for roadway infrastructure. The location data associated with AV may facilitate new funding opportunities, including user charges on a per mile basis, which could be adjusted to reflect demand and reduce congestion. No legislation has included this kind of fee, although early versions of legislation in Tennessee did include a mileage-based fee for AV, which was removed in the version that passed (SB 1561, 2016). Nevada specifies an excise tax for autonomous vehicle network companies (AB 69, 2017), with a 3% tax on the total fare. A fee to cover administrative costs for authorization of an automated vehicle is often authorized (e.g., California SB 1298, 2012), as well. Some states specify that local jurisdictions cannot charge fees (e.g., Michigan SB 995, 2016; Nevada AB 69, 2017), although Nevada allows a local jurisdiction, including airports, to charge a fee for a business license if this is consistent with standard charges for permits.

7. INSURANCE AND LIABILITY

Insurance and liability is addressed by all states for traditional motor vehicles, and is also a common topic for AV legislation. The first AV legislation in Nevada

directed the DMV to adopt rules for insurance and safety standards (AB 511, 2011). Subsequent Nevada legislation required proof of \$5M liability insurance for testing (SB 313, 2013), which has been maintained in the most recent legislation (AB 69, 2017) and is a common requirement in other states, as well (e.g., California AB 1592, 2016; Connecticut SB 260, 2017).

Texas requires that automated vehicles carry the same insurance coverage as other vehicles (SB 2205, 2017), and Colorado (SB 213, 2017) and Tennessee (SB 151, 2017) specify that the liability is consistent with state law, federal law or common law. Insurance requirements may vary depending on the level of automation and or operating framework. Georgia specifies that AV without a human driver must carry 250% of the insurance usually required, although this will revert to typical coverage in 2020 (SB 219, 2017).

Michigan legislation has addressed many aspects of insurance. Michigan requires proof of insurance before conducting testing on a roadway without a human operator (SB 995, 2016) and has addressed insurance for the manufacturer of the automated technology (SB 169, 2013), AV liability for upfitters when third parties provide conversions (SB 663, 2013), liability for mechanics and auto repair providers (SB 998, 2016), and for manufacturers when changes are made without their consent (SB 997, 2016). Michigan also has addressed liability for auto manufacturers who have AV fleets for ridesharing in a SAVE project (SB 995, 2016), specifying that the manufacturer must have \$10M in liability insurance and shall be liable when the ADS is at fault (Michigan SB 996, 2016).

8. VEHICLE INSPECTION REQUIREMENTS

Vehicle standards are currently provided by the federal government and auto manufacturers self-certify that vehicles meet the requirements of the FMVSS (NHTSA, 2016). As long as automated vehicles meet these standards, there are no legal restrictions to their sale and use on public roadways. It is expected that vehicle standards and compliance will remain the domain of the federal government for AV.

Since the framework for certification of automated vehicles is still evolving, the FAVP has outlined a 15-point safety assessment checklist (Table 2.2) and suggests that manufacturers and other entities who wish to test AV use this assessment, and identify whether each of the 15 point items is met, not met, or not applicable.

This does not preclude states from including a vehicle inspection component as part of the process required for AV testing and in fact inspections are included as part of the NHTSA Model State Plan. Consistent with this concept, the Massachusetts Executive Order requires that vehicles have passed a Registry of Motor Vehicles inspection (Exec. Order No. 572, 2016), and Nevada legislation addresses vehicle inspections for AV taxi companies (AB 69, 2017). Both of these applications are consistent with the FAVP model state

legislation which retains vehicle inspection as a state responsibility (NHTSA, 2016).

More common, especially in recent legislation, is deference to compliance with existing state and federal legislation. This is evidenced by the recent AV legislation from Texas (SB 2205, 2017) and Colorado (SB 213, 2017) which require compliance with federal motor vehicle safety standards and federal law. Vehicle inspection is an area that has been identified as appropriate for investigation by committees and agencies tasked with studying and reporting on AV issues (e.g., North Dakota HB 1202, 2017).

9. OPERATOR REQUIREMENTS

Operator requirements for AV vary significantly in different states. States may recognize different operator requirements for vehicles with human operators present in the vehicle versus those without human operators, for different levels of automation, and for testing versus operation.

Operator requirements were addressed in the first legislation in Nevada in 2011 (AB 511) which required the DMV to establish a driver's license endorsement for AV operation, and recognized that an AV can drive without a human operator. Other states that allow AV without a human driver include Arizona (Exec. Order No. 2015-09, 2015), California (AB 1592, 2016), Colorado (SB 213, 2017), Florida (HB 7027, 2016), Georgia (SB 219, 2017), Michigan (SB 996, 2016), Tennessee (SB 151, 2017) and Texas (SB 2205, 2017). Legislation in many states does not address the driver issue (e.g., Vermont HB 494 2017; Virginia HB 454, 2016; South Carolina HB 3289, 2017; North Dakota HB 1202, 2017; Pennsylvania SB 1267, 2016; Utah HB 280, 2016). Some states explicitly require a driver in the vehicle and manual override capabilities, including Washington, DC (DC Act 19-643, 2012), Washington (Exec. Order No. 17-02, 2017), Massachusetts (Exec. Order No. 572, 2016), New York (SB 2005, 2017) and Connecticut (SB 260, 2017).

Operator requirements have changed over time in many states. In 2012, California required that the driver must be sitting in the driving seat and monitoring the system in case of failure or emergency (SB 1298). This legislation also allowed flexibility for the department to allow and impose additional requirements for vehicles without a driver in the future. In 2016, California legislation (AB 1592) waived the rule requiring a driver and provided authorization for the Contra Costa Transportation Authority to conduct tests of AV without a driver, steering wheel, brake pedal, or accelerator. California's 2016 legislation also recognized the role for a remote operator and required two-way communications at all times between the vehicle and the remote operator. Following up on the initial legislation, in 2017 the California DMV published revised regulations for driverless testing and deployment (California DMV, 2017), reflecting advancements in driverless technologies and the need to meet this emerging market.

The framework for operator requirements also changed in Florida. In 2012 legislation, (HB 1207), Florida required that a person be present in the vehicle for testing and that the operator be a representative of the manufacturer. In 2016, legislation (HB 7027) specified that AV can be tested without a person in the vehicle, and any licensed driver can operate an AV, shifting from a framework focused on testing to a framework intended for operations.

Michigan also allowed operation without a person in the vehicle in 2016 (SB 996), specifying that an ADS shall be considered the driver or operator when engaged. This designation is relevant for conformance to traffic laws, and clarifies that it can electronically satisfy all physical acts required by a driver or operator of the vehicle.

Nevada law specifically states that no traffic or motor vehicle laws shall require a human driver to operate a fully autonomous vehicle (AB 69, 2017).

“The automated driving system of a fully autonomous vehicle shall, when engaged, be deemed to fulfill any physical acts which would otherwise be required of a human driver except those acts which by their nature can have no application to such a system.”

Similar laws exist in other states, including Tennessee (SB 151, 2017), Colorado (SB 213, 2017) and Texas (SB 2205, 2017). In Texas, the ADS is licensed to operate the vehicle, but the owner of the ADS is considered the operator for the purpose of assessing compliance with traffic laws, regardless of whether the person is physically present in the vehicle.

As technologies progress, more states have included language that differentiates operator requirements for a human operator. Colorado refers to a human operator as a natural person in the vehicle with access to steering, braking and acceleration and refers to an ADS as the hardware and software that can perform all aspects of the driving task (at L4 and L5) without intervention or supervision by a human operator. Tennessee designates the operator as the person in actual physical control for a conventionally operated vehicle, as well as the person in control of the lead vehicle in a platoon (SB 676, 2016).

Georgia (SB 219, 2017) defines an operator as a person who drives, is in actual physical control, or causes a fully autonomous vehicle to travel with the ADS engaged. Georgia also exempts the operator of a fully autonomous vehicle from driver license requirements if the ADS is engaged. Other recent legislation has taken a much more traditional approach. Both Connecticut (SB 260, 2017) and New York (SB 2005, 2017) authorize testing but not operation, and require that a licensed operator be seated in the driver’s seat.

In some cases, the definition of operator has implications beyond merely controlling the vehicle. In 2011, Nevada deemed that people in AV are not considered operators when it comes to restrictions on cell phone usage in a vehicle. Other legislation that exempts restrictions related to cell phones and other potentially

distracting devices include Virginia (HB 454, 2016), Tennessee (SB 2333, 2016) and Florida (7061, 2016), which waive limits on TV displays, integrated electronic displays, and electronic displays used in conjunction with truck platooning technology, respectively. Michigan waives cell phone use for people using SAVE, an on-demand AV taxi (Michigan SB 995, 2016). Indiana’s current legislation related to cell phone restrictions is shown in Appendix C.

In many cases the operator requirements for testing mandate that the operator be an employee or agent of the manufacturer or a university. In fact, this is one way FAVP differentiates testing from operation; the other component is that purpose of testing is to collect data for analysis. Illustrating this concept, Michigan legislation (SB 995, 2016) requires the vehicle be operated only by an employee, contractor, or other person designated or otherwise authorized by the manufacturer of the ADS or upfitter, and excludes the application of this requirement in limited cases, such as for a university researcher or an employee of the DOT. Operator requirements may also address licensing, registration and insurance requirements, as previously discussed.

10. INFRASTRUCTURE

Adequate infrastructure is important for the safe operation of all vehicles, including AV. Future infrastructure needs may vary depending on the AV application, and the variety of proprietary technologies make it difficult to predict future infrastructure requirements with certainty or specificity. It has been suggested that there are no additional infrastructure requirements for AV, because AV technology that requires special infrastructure would not be viable in a competitive market. Other reports suggest that infrastructure is important: some AV may depend on high contrast lane markings, connected vehicles may require signals that transmit key parameters for optimal performance, and other AV applications may benefit from robust dynamic mapping and traffic data providing in real time for the corridor or network.

Pennsylvania’s AV legislation is limited (SB 1267, 2016), but it does allow funds that are allocated to municipalities for upgrading traffic signals to include intelligent transportation system applications, which includes AV and CV technologies, in addition to other uses. There was no suggestion that the \$40,000,000 in allocated funds was increased to provide for AV or CV applications, nor any requirement that the funds be used for these ITS applications rather than other allowable uses.

The need for future AV infrastructure is also acknowledged in Florida legislation (HB 7027, 2016), which requires that infrastructure and technology improvements needed to accommodate autonomous vehicle and related technology must be included in the statewide Strategic Intermodal System Plan, as well as the long-range transportation plans developed by Florida MPOs across the state. In some cases, infrastructure is a topic

for investigation. For example, the Wisconsin Executive Order (Exec. Order No. 245, 2017) mandates that the committee identify roads that should be designated special corridors for AV and CV testing and operation. In other cases, state agencies are changing their infrastructure without legislative mandate. For example, California DOT is changing lane markings from 4" wide to 6" wide to increase conspicuity for AV as well as human drivers (Carpenter, 2017). California is also moving away from raised pavement markers after decades of use since AV have a hard time following them (Carpenter, 2017).

11. VEHICLE TESTING

The FAVP differentiates HAV testing from operation based on whether manufacturers or their designees are operating the vehicles, and whether the resulting data is being used for analysis (NHTSA, 2016). However, with respect to both legislative intent and practice, in some cases it is difficult to differentiate between vehicle testing and operation.

Vehicle testing has been reportedly highest in Arizona (including Phoenix, Scottsdale, Tempe and Chandler), Pennsylvania (Pittsburgh), Michigan (Detroit) and California (San Francisco) (Burden, 2017). Many states

have explicitly acknowledged the intent to facilitate vehicle testing. The first legislation in Nevada provided authorization for testing and operation (Nevada AB 511, 2011). Similarly, early legislation in Florida (HB 1207, 2012) and Michigan (SB 167, 2013) authorized AV testing. In both cases, subsequent legislation changed or clarified requirements. Florida (HB 7027, 2016) removed requirements associated with testing, and Michigan clarified requirements with respect to insurance and operators.

Some states require specific authorization for testing. California was a lead state in early AV testing activities since it is home to many technology firms. The need for authorization and mandatory reporting has allegedly caused many firms to test vehicles in other states. In addition to permits, California requires detailed reports on vehicle disengagement and accidents or incidents, which are then made publicly available. Thirty-six companies have obtained permits to test AV in California, and in 2016 Google reported AV driving 635,868 miles. Sample data from reports required by California are shown Table 11.1 and Figure 11.1. As can be seen in Table 11.1, the number of miles driven varies dramatically, as does the disengagement rate. Figure 11.1 illustrates the dramatic increase in miles driven in autonomous mode and a corresponding reduction in

TABLE 11.1
Sample Disengagement Data Reported in California

Company, year	Autonomous miles	Reportable disengages	Disengagements per 1,000 miles
Google, 2015	424,331	341	0.80
Google, 2016	635,868	124	0.20
BMW, 2016	638	1	1.57
Mercedes Benz, 2016	673	336	498.95
GM Cruise, 2016	9,730	149	15.31

Source: California DMV (2017).

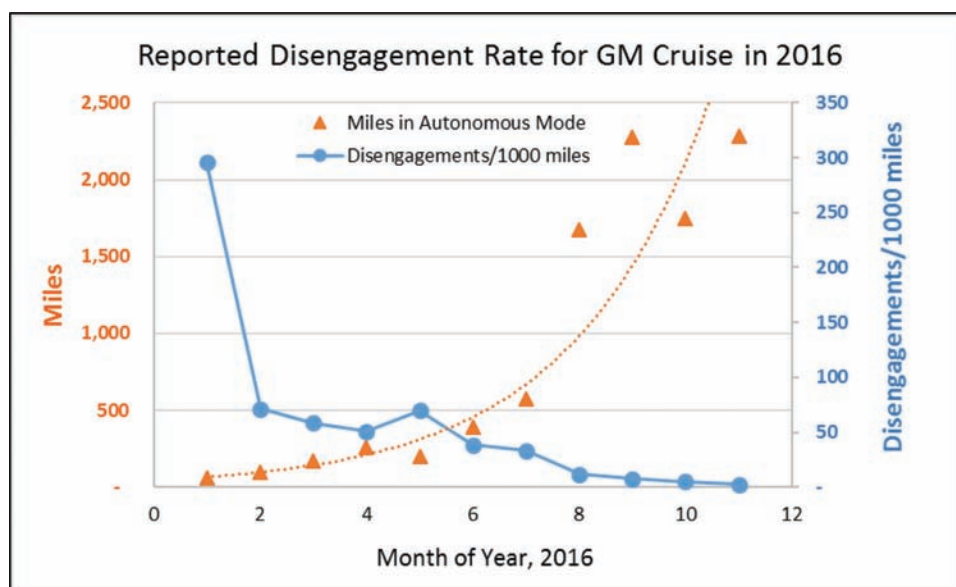


Figure 11.1 Sample AV Disengagement Data Reported in California. (Source: California DMV, 2017.)

the disengagement rate for GM Cruise as reported for testing in 2016. Disengagement may be manual or automatic; it also may be part of planned testing and does not represent a failure of automation capabilities. Additional information reported to California is provided in Appendix E (California DMV, 2017).

Other states do not require data reporting or authorization for testing. Testing in Arizona requires only a standard vehicle registration (Marshall, 2017); testing in Colorado and Texas requires approval only if the ADS does not comply with state and federal law. In Colorado, systems that are not compliant with current regulations need to be approved by the Colorado State Patrol and the Colorado DOT.

It is not unusual for the DOT and the State Patrol (aka State Police or Department of Public Safety), as well as the DMV (aka Commissioner, Bureau or Department of Motor Vehicles) to be formally involved in AV testing. In New York, legislation requires AV tests be approved the Commissioner of Motor Vehicles and supervised by the State Police (SB 2005, 2017). This has translated to a requirement for police escort for all AV testing in New York (Marshall, 2017).

In some cases, testing is limited to an operational domain or technology. For example, Arkansas legislation regulates AV testing for driver-assistive truck platooning technology (Arkansas HB 1754, 2017) and Utah legislation authorized a CV technology testing program (HB 373, 2015). Connecticut prohibits AV testing for a fully autonomous vehicle on any limited access highway (Connecticut SB 260, 2017).

12. OPERATION ON PUBLIC ROADS

The framework for operation is often analogous to the framework to test AV, and in some states AV can be operated as long as they meet all federal requirements and state requirements (e.g., Colorado SB 213, 2017; Florida HB 7027, 2016; Texas SB 2205, 2017). In many states, legislation specifies requirements for license, registration and insurance requirements, and sometimes a human operator, as previously discussed. For example, Texas does not require a licensed human operator for operation, but does require registration, title and liability insurance, as well as a recording device (SB 2205, 2017). North Carolina does not require an operator to have a driver license, but does require that an adult accompany passengers under 12 (HB 469, 2017).

In terms of operational considerations, Florida permits operation of an AV if the AV alerts the operator of system failure and if the operator can take control of the vehicle or assure that the automated system will safely bring the vehicle to a complete stop (HB 7027, 2016). This is referred to as minimal risk condition, which is included in the 15-point vehicle safety assessment (NHTSA, 2016) and which Georgia (HB 472, 2017) defines as follows:

“a low-risk operating mode in which a fully autonomous vehicle operating without a human driver achieves a reasonably safe state, such as bringing the vehicle to a

complete stop, upon experiencing a failure of the vehicle’s automated driving system that renders the vehicle unable to perform the entire dynamic driving task.”

Georgia law also specifies that no rules or regulations relative to the operation of autonomous vehicles or ADS shall limit the authority to operate such vehicles or systems.

Michigan outlines a framework for AV operation (SB 995, 2016; SB 996, 2016; SB 997, 2016; SB 998, 2016) that allows operation of an AV without a human operator in the vehicle, specifies that the ADS is the operator when the system is engaged, and designates the SAVE program, which allows operation of on-demand AV taxis by motor vehicle manufacturers. This supports Michigan’s auto industry, but was opposed by technology companies such as Google and Uber (Korosec, 2016). Nevada also has legislation addressing the operation of AV network companies (AB 69, 2017).

13. COMMERCIAL VEHICLE OPERATIONS AND PLATOONING

AV applications for commercial vehicle operations (CVO) may include a variety of technologies, many of which are analogous to the technologies used for passenger cars. The most active area for CVO legislation is to allow commercial vehicles to operate in platoons with reduced headway between vehicles; supporting legislation has been passed in five states in 2017: Arkansas (HB 1754), Georgia (HB 472), South Carolina (HB 3289), Tennessee (SB 676), and Texas (HB 1791). Platooning legislation has also been incorporated into broader AV legislation (e.g., Nevada AB 69, 2017). In many cases, the legislation exempts the standard following distance requirement for vehicles travelling in a platoon. This legislation is not required in all states, particularly states that currently specify a reasonable and prudent following distance. Michigan’s legislation (SB 995, 2016) provides an illustration of the many considerations that may affect safe following distance, specifying a reasonable and prudent following distance, with an exception for vehicles over 5,000 pounds which must maintain a following distance of at least 500 feet if they are outside of a city, unless they are travelling in a platoon.

Legislative interest in this topic has been fostered by technology companies that are developing platooning systems. These systems were first demonstrated in Europe in March 2016 (Hirsch, 2016). System benefits include reduced fuel consumption (with associated cost reductions) and reduced emissions. The second truck can reportedly begin braking within 0.3 seconds of the time the first truck begins braking, which allows a much closer following distance. The length of a platoon may be limited to two vehicles (e.g., Florida 7061, 2016) or of unlimited length (e.g., Arkansas HB 1754, 2017; Michigan SB 995, 2016). In some states the platoon length is not explicitly addressed (e.g., Georgia AB 472, 2017). Tennessee legislation specifies that each vehicle must have a driver with a commercial driver

license (CDL) behind the wheel, and differentiates the driver of the lead vehicle for regulatory purposes (SB 676, 2016).

Florida (HB 7061, 2016) and Utah (HB 373, 2015) legislation required a study on the use of driver assistive truck platooning technology. Multiple states require that a plan for platoon operations be filed with the DOT or another state agency (e.g., Arkansas HB 1754, 2017; Michigan SB 995, 2016; Tennessee SB 676, 2016), providing a minimum number of days for the agency to review prior to the initiation of testing (e.g., 30 days in Tennessee and Michigan, and 45 days in Arkansas). A sample of legislation that has been proposed for Indiana is shown in Appendix C. Current Indiana legislation related to following distance is shown in Appendix D.

14. PRIVACY

Automated and connected vehicles generate extensive data, including location data, vehicle data (e.g., acceleration, braking, and speed data), and information about the environment (e.g., other vehicles and pedestrians). AV ride sharing services also collect data linked with specific users, including travel data. Personal data collected during travel (e.g., search engines, emails and businesses data accessed via devices linked with the vehicle) may also be vulnerable to the extent that personal devices are linked with the vehicle and thus accessible.

Vehicle data may be of interest in case of an incident or crash, and may also be useful to document infrastructure conditions (including potholes) or identify locations where pedestrians may be more vulnerable or potential hazards exist. A protocol that provides access to accident data when needed (including access and storage requirements), protects user privacy, and assures protection of propriety components of software, is important.

A number of states have developed legislation to address user privacy. In Michigan and Nevada, legislation addresses privacy and data handling practices for passengers of AV taxi services (Michigan SB 996, 2016; Nevada AB 69, 2017). In California, the initial legislation in 2012 required that the manufacturer must provide notification of data collected to purchaser (SB 1298), and subsequent legislation requires disclosure of what personal information concerning a participant is collected by AV (California SB 1592, 2016).

14.1 Accident Reporting and Safety

Numerous states require that accident data be stored and retained (e.g., California SB 1298, 2012; Nevada AB 69, 2017). California requires data must be collected 30 seconds before an accident, and must be retained for 3 years. California also makes information more widely available, publishing both accident and disengagement data. Since testing began and as of July 20, 2017, there have been 34 reported accidents involving

TABLE 14.1
Automated Vehicle Accidents Reported in California

Year	Number of accidents reported
2017 (through July 6)	8
2016	15
2015	9
2014	1

Source: California DMV (2017).

automated vehicles in California, as shown in Table 14.1. California requires a standard form for reporting that includes the accident conditions (stopped or moving in traffic), the number of vehicles involved, and whether pedestrians or bicyclists were involved (California DMV, 2017). Even states that have not promulgated data or privacy legislation have recognized that it is an issue, as evidenced by states such as North Dakota, with legislation that requires a mandated study to include information about data information and storage.

Texas requires that AV follow the same accident procedures as other vehicles (SB 2205, 2017). Georgia (SB 219, 2017) requires a fully autonomous vehicle that is involved in an accident remain on the scene and promptly contact law enforcement. Georgia law (SB 219, 2017) also specifies that occupants of a fully autonomous vehicle are responsible for compliance with laws regarding safety belts and child passenger restraints.

Related to safety, AV may present special concerns for emergency responders. This has been recognized by states such as Vermont that have required a report to address emergency response practices (HB 494, 2017) and by states such as California that require an interaction plan be provided to assure that responders have the information needed to safety interact with an AV (AB 1592, 2016).

15. OTHER CONSIDERATIONS

In addition to the topics previously addressed, there are a number of other considerations that may affect state legislation as well as the underlying motivation for state legislation, namely to support or regulate AV activities. These considerations include cybersecurity, local laws and ordinances, federal laws that are under development and consideration, and recognition that the environment in which legislation occurs is very dynamic.

15.1 Cybersecurity

Cybersecurity is a significant consideration for the safe and reliable operation of AV. It is a recognized concern for potential users, technology developers, states and federal governments, however, there have not been any states that have included cybersecurity as part of their legislation. As a result, the cybersecurity domain is currently left to technology developers and manufacturers, as well as the federal government, including not only NHTSA, but also intelligence agencies

(e.g., Federal Bureau of Investigation) and security agencies (e.g., Department of Homeland Security and Transportation Security Administration).

The Government Accountability Office (GAO) has published a report on cybersecurity for AV that identifies many potential opportunities for system vulnerability (GAO, 2016). Sample opportunities to mitigate threats are shown in Figure 15.1. NHTSA is currently examining needs and potential regulations for vehicle cybersecurity; however, final recommendations are not expected until at least 2018.

The potential for harm even with lower levels of autonomy was demonstrated in 2015 when a Jeep Cherokee was remotely hacked via an internet connection. The cybersecurity of future AV includes vulnerabilities of communications, controls and infrastructure, as well as physical access to shared vehicles (Greenberg, 2017).

Demonstrations that have leveraged physical (wired) or internet access to vehicles have shown how it is possible to disable or slam on a victim’s brakes, turn the steering wheel, or accelerate; in almost all cases, vehicles’ automated features were the mechanism to facilitate control. A collision avoidance system can be used to apply the brakes, a cruise control feature can be used to accelerate, and the parking assist feature can be used to turn the steering wheel, in one case, even though the vehicle was travelling at 80 miles an hour. While a driver could override many of attacks, if there is no driver, or if there is no steering wheel or brake, it is more challenging to recover from a cyberattack (Greenberg, 2017). Although cybersecurity is part of the FAVP 15-point safety assessment for AV, the DOT has not yet clearly define its role when it comes to cybersecurity (GAO, 2016).

15.2 Local Laws

As noted by the FAVP, vehicles must operate within constraints of not only state laws but also federal regulations and local laws and ordinances. Local jurisdictions

typically have the right to regulate vehicle operations through speed limits and other motor vehicle laws. State legislation related to AV has addressed this topic with a range of philosophies, reflecting different perspectives on the role of state and local authority.

At one end of the spectrum, Massachusetts requires that AV testing and operations have the consent of the local jurisdiction, as evidenced by a Memorandum of Understanding (MOU) (Exec. Order No. 572, 2016). California requires that local jurisdictions provide approval in the case of testing of AV without driver (AB 1592, 2016).

At the other end of the spectrum, some states explicitly restrict local jurisdictions from regulating AV operation. Texas, Colorado and North Carolina (Texas SB 2205, 2017; Colorado SB 213, 2017; North Carolina HB 469, 2017) explicitly state that regulation of AV is a statewide concern, and local agencies or political subdivisions cannot adopt rules or policies or ordinances that would set standards other than those adopted by the state. Texas further clarifies that neither shall any state agency impose additional regulations related to AV operations (Texas SB 2205, 2017).

State laws may address AV topics in other areas, too. Michigan allowed that local agencies could be represented on the Michigan Council on Future Mobility (SB 995, 2016), although their participation was not mandated. The Executive Order in Washington State, however, does mandate that the work group include local governments (Exec. Order No. 17-02, 2017). As mentioned previously with respect to infrastructure, Florida requires that local agencies incorporate AV needs in their long-range transportation plans (HB 7027, 2016). A previous section also discussed local jurisdictions ability to charge fees in the Fees and Funding section under Licensing and Regulations.

15.3 Federal Laws

Legislation at the federal level includes 14 bills that have been proposed for implementation. The legislation

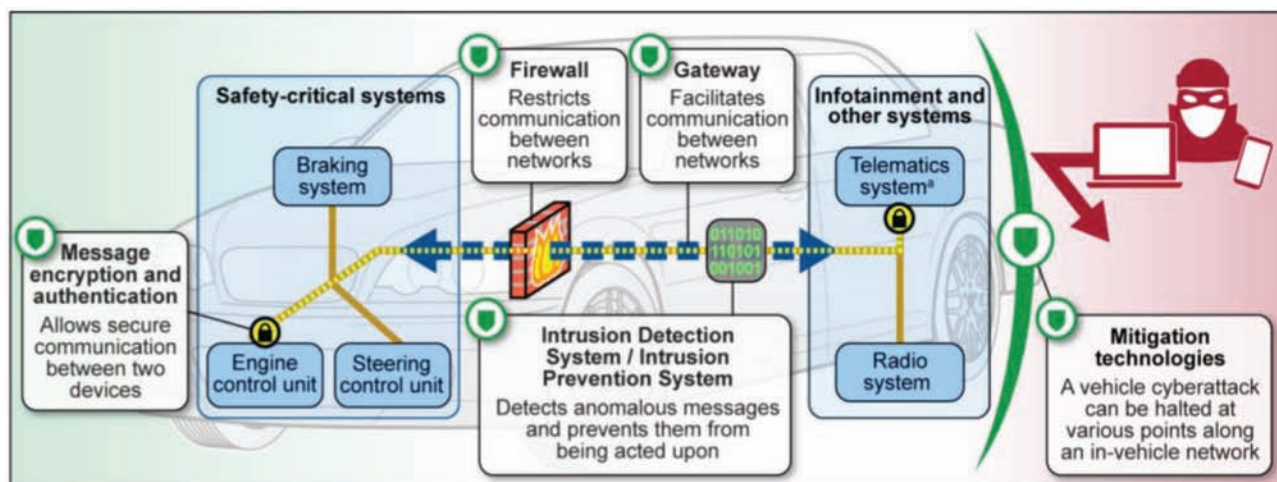


Figure 15.1 Potential mitigation technologies to support in-vehicle cybersecurity (US Government Accountability Office, 2016).

has six priorities: improve safety, foster innovation, remain technology neutral, clarify and separate federal and state roles for AV, ensure cybersecurity and support public education. Collectively, this legislation would reduce potential obstacles to implementation, give NHTSA authority over HAV, prevent states from restricting the testing or development of AV, and increase the number of vehicles eligible for testing. States would retain the right to regulate registrations, licensing, insurance, traffic laws and driver training. In terms of vehicle testing, current laws limit the number of vehicles exempt under the FMVSS to 2,500 per year, under the proposed law, this would be increased to 100,000 per year; these exemptions are needed for vehicles that do not meet current safety standards, and includes vehicles that do not have steering wheels, accelerators, or brakes (Graham, 2017). On July 19, 2017, a House Commerce consumer protection panel passed a bill by voice vote; if it becomes law, it will be the first federal legislation regarding AV (Neidig, 2017).

15.4 Dynamic Environment

State laws may be intended to facilitate and encourage AV and associated economic development, or may be intended to carefully regulate AV to ensure safe deployment, citizen privacy, and the exercise of local rights to self-government. As mentioned previously, legislation may not be necessary for AV to operate legally, and it may not be the most important catalyst to spur AV activities. As noted by one technology firm, “It is the lack of regulations that really makes Arizona attractive. In the U.S., if it isn’t illegal, it’s legal. Arizona hasn’t passed laws on the subject – that actually makes it easier to operate there” (Burden, 2017).

Perhaps this philosophy is supported by states such as Tennessee and Georgia, which have AV legislation that does not constrain or burden AV activities; however, there have been limited reports of AV testing or operation in these states. Many states use legislation to signal industry that they welcome AV and associated economic development. This approach has met with mixed success. Arizona’s executive order in 2015 has been supported a number of successful initiatives in a variety of cities; Michigan’s legislation and test track has supported the activities of their legacy auto manufacturing industry, and California’s legislation has provided a framework for extensive testing, although there are indications that many companies have chosen to expand testing in other states where reporting requirements are less burdensome (Gear, 2016). Pennsylvania has limited AV legislation, although Pittsburgh has been the site for extensive AV testing, partly due to partnerships with Carnegie Mellon and university related technology firms. Similarly, Ohio does not have AV legislation, but has extensive AV activity, and substantial AV investments by both public and private sector partners.

Quantifying AV activity and impact can be challenging since most states do not have reporting requirements, and unless companies wish to use testing for marketing and publicity, they may choose to test with little fanfare since technology development has proprietary considerations. For this reason, companies announce partnerships and programs in cities, but often do not publish details regarding how testing efforts are distributed across different locations. For example, Uber is testing 150 AV in Pittsburgh, San Francisco and Tempe, and GM will add 130 Bolt AV to their fleet of 50 AV being tested in Scottsdale, San Francisco and Michigan, but neither company specifies how many vehicles are being tested in each location (Burden, 2017).

Testing is also influenced by federal activities. The US DOT identified AV testing sites in the following nine states: Pennsylvania (Pittsburgh), Texas (Proving Grounds Partnership in Arlington), Maryland (Aberdeen), Michigan (Willow Run, between Ypsilanti), California (Contra Costa and San Diego), Iowa (Iowa City), Wisconsin (Madison), Florida (Central Florida Partners include Orlando, the Central Florida Expressway, Kennedy Space Center), and North Carolina (Turnpike) (USDOT, 2017). Consideration of these nine states illustrates that it is not necessary to have state legislation to have vehicle testing underway, since the majority of these states (Texas, Maryland, Iowa, Wisconsin and North Carolina) did not have AV legislation when the designation was awarded and two of these states (Maryland and Iowa) still do not have legislation.

Similarly, Columbus, Ohio, was designated a SMART City, and Ohio has a number of AV initiatives underway, although Ohio does not have AV legislation. Columbus reportedly used \$40M from the US Department of Transportation and \$10M from industry partner Vulcan as a catalyst for \$500M in investments (as of May 2017), with aspirations for \$1B from the private sector within the next four years (Maddox, 2017). Ohio is also home to the Smart Mobility Advanced Research and Test (SMART) Center, supported by a \$45M investment by the state and Ohio State University (OSU) (IW Staff, 2017); the Smart Mobility Corridor, supported by \$15M from the state and funds through a public private partnership that includes industry, Dublin OH, OSU, and the Transportation Research Center (Johnson, 2017).

There are clearly a variety of ways to try to spur AV activities, and no one solution. Rhode Island (2017) and Portland, Oregon (2017) are taking a different approach, and have sought AV partnerships via requests for proposals.

There are many firms that are potential partners for AV activities. Although tech firms such and auto-makers often get much of the publicity when it comes to AV, there are numerous other private companies that are involved in the sector. Companies may provide technologies to support AV for passenger cars as well as commercial vehicles, public transportation, freight and

TABLE 15.1
Expected Year of Deployment for L3, L4 and L5 Technologies

Organization	Forecasted year of deployment	Automation level
Ford Motor Company	2021	L4
Uber	2021	Not specified
Volvo	2021	L4
General Motors	2020	Not specified
Tesla	2018	L3 or L4
Google	2020	L4
National Association of City Transportation Officials	2020	L4
IHS Markit (Market Research Company)	2020	L4 and L5
ABI Research (Market Research Company)	2021	L4 and L5

Source: Lewis et al. (2017).

even motorcycles and bicycles, and may include the following sectors (Stewart, 2017):

- Onboard sensor companies – cameras, GPS positioning, LiDAR and radar,
- Intelligent manufacturing companies – advanced materials, 3D printing, automated assembly lines,
- Infrastructure and connected cars – fleet and traffic management, data platform and software development for connected cars,
- Mapping, simulation and image recognition,
- In-car intelligence and assistance – vehicle diagnostics, passenger focused sensors, infotainment and displace, personal assistance,
- Safety and security and services – parking and route planning, carpooling.

The corporate framework is further complicated by changes that include mergers, acquisitions, alliances and partnerships among companies, as well as university and public sector partners (Stewart, 2017). In some cases, partnerships and competitors have faced challenges. Uber’s collaborative relationship with Carnegie Mellon suffered after Uber hired away numerous faculty and technicians (Reuters, 2016). Legal battles such as Waymo’s lawsuits against Uber and Otto for alleged trade secret violations illustrate the high stakes associated with large investments and potential markets (Etherington, 2017). Activity is robust, and the AV market is strong and is expected to continue to grow, with projections suggesting automotive revenue may increase by 30 percent (which is \$1.5 trillion) by 2030; for comparison, the market in 2015 was approximately \$3.5 trillion (McKinsey, 2016). Implementation expectations vary dramatically, and while no one can be certain how quickly technologies will be deployed, one recent study suggests that technologies with L3 and above will be deployed within five years by a number of companies, as shown in Table 15.1 (Lewis, Rogers, & Turner, 2017).

15.5 Legislative Activity

Activity is also ramping up in terms of legislation. According to the National Council of State Legislature (NCSL, 2017), in 2017 as of July 7, there have been 97 proposed bills in 33 states related to AV, and 16

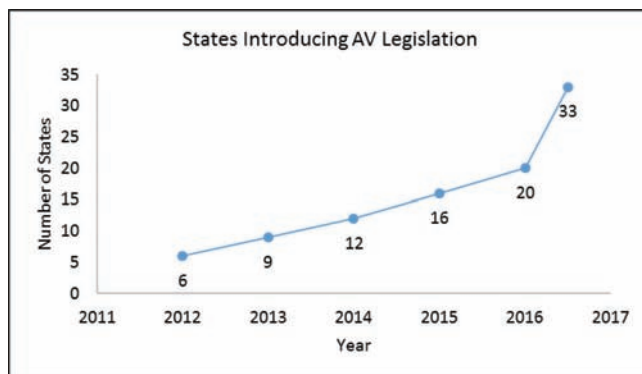


Figure 15.2 Increase in state AV legislation introduced. (Source: NCSL, 2017.)

of these have been enacted in 13 states, as shown in Figure 4. This is a dramatic increase from previous years, and proposed legislation in the first half of 2017 is significantly higher than in all of 2016, when 20 states considered AV legislation (NCSL, 2017).

16. CONCLUSIONS

AV technology is rapidly advancing and has created a dynamic environment for companies, as well as for states and government agencies. States have taken a variety of approaches to AV legislation, and similar legislation has had different outcomes in terms of AV activities, which illustrates that legislation is one of many factors that is considered when companies are deciding where to test and deploy their vehicles. The breadth of legislation that has been enacted, as well as the four executive orders, provide a wealth of information for Indiana to learn from, and to consider when charting a path for the future.

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APPENDIX A: FEDERAL AUTOMATED VEHICLE POLICY MODEL STATE POLICY

Source: US Department of Transportation (2016). <https://www.transportation.gov/AV/av-fact-sheet-model-state-policy>.

FACT SHEET: AV POLICY SECTION II: MODEL STATE POLICY

State governments play an important role in facilitating HAVs, ensuring they are safely deployed and promoting their life-saving benefits. The Model State Policy confirms that States retain their traditional responsibilities for vehicle licensing and registration, traffic laws and enforcement, and motor vehicle insurance and liability regimes while outlining the Federal role for HAVs. The Model State Policy supports the establishment of a consistent national framework of laws and policy to govern automated vehicles.

Division of Federal and State Responsibilities

Federal responsibilities include:

- Setting safety standards for new motor vehicles and motor vehicle equipment;
- Enforcing compliance with the safety standards;
- Investigating and managing the recall and remedy of non-compliances and safety-related motor vehicle defects on a nationwide basis;
- Communicating with and educating the public about motor vehicle safety issues; and

- When necessary, issuing guidance to achieve national safety goals

State responsibilities include:

- Licensing (human) drivers and registering motor vehicles in their jurisdictions;
- Enacting and enforcing traffic laws and regulations;
- Conducting safety inspections, when States choose to do so; and
- Regulating motor vehicle insurance and liability.

The Model State Policy

The Model State Policy is intended for States that wish to regulate testing, deployment, and operation of HAVs. The model framework addresses State regulation of the procedures and requirements for granting permission to vehicle manufacturers and owners to test and operate vehicles within a State.

Model framework areas covered include:

- Administrative structure and processes that States can set up to administer requirements regarding the use of public roads for HAV testing and deployment in their States;
- Application by manufacturers or other entities to test HAVs on public roads;
- Jurisdictional permission to test;
- Testing by the manufacturer or other entities;
- Drivers of deployed vehicles;
- Registration and titling of deployed vehicles;
- Law enforcement considerations; and
- Liability and insurance.

APPENDIX B: SUMMARY OF STATE LEGISLATION

Source: National Conference of State Legislatures (June 26, 2017). Autonomous Vehicles. <http://www.ncsl.org/research/transportation/autonomous-vehicles-self-driving-vehicles-enacted-legislation.aspx#enacted>

Enacted Legislation

State	Bill Number	Relevant Provisions
Alabama	SJR 81 (2016)	Established the Joint Legislative Committee to study self-driving vehicles.
Arkansas	HB 1754 (2017)	Regulates the testing of vehicles with autonomous technology, relates to vehicles equipped with driver-assistive truck platooning systems.
California	SB 1298 (2012)	Requires the Department of the California Highway Patrol to adopt safety standards and performance requirements to ensure the safe operation and testing of autonomous vehicles, as defined, on the public roads in this state. Permits autonomous vehicles to be operated or tested on the public roads in this state pending the adoption of safety standards and performance requirements that would be adopted under this bill.
California	AB 1592 (2016)	Authorizes the Contra Costa Transportation Authority to conduct a pilot project for the testing of autonomous vehicles that are not equipped with a steering wheel, a brake pedal, an accelerator, or an operator inside the vehicle, if the testing is conducted only at specified locations and the autonomous vehicle operates at specified speeds.
Colorado	SB 213 (2017)	Defines automated driving system, dynamic driving task and human operator. Allows a person to use an automated driving system to drive or control a function of a motor vehicle if the system is capable of complying with every state and federal law that applies to the function that the system is operating. Requires approval for vehicle testing if the vehicle cannot comply with every relevant state and federal law. Requires the department of transportation to submit a report on the testing of automated driving systems.
Connecticut	SB 260 (2017)	Defines terms including “fully autonomous vehicle,” “automated driving system,” and “operator.” Requires the development of a pilot program for up to four municipalities for the testing of fully autonomous vehicles on public roads in those municipalities. Specifies the requirements for testing, including having an operator seated in the driver’s seat and providing proof of insurance of at least \$5 million. Establishes a task force to study fully autonomous vehicles. The study must include an evaluation of NHTSA’s standards regarding state responsibility for regulating AVs, an evaluation of laws, legislation and regulations in other states, recommendations on how Connecticut should legislate and regulate AVs, and an evaluation of the pilot program.
Florida	HB 1207 (2012)	Defines “autonomous vehicle” and “autonomous technology.” Declares legislative intent to encourage the safe development, testing and operation of motor vehicles with autonomous technology on public roads of the state and finds that the state does not prohibit or specifically regulate the testing or operation of autonomous technology in motor vehicles on public roads. Authorizes a person who possesses a valid driver’s license to operate an autonomous vehicle, specifying that the person who causes the vehicle’s autonomous technology to engage is the operator. Authorizes the operation of autonomous vehicles by certain persons for testing purposes under certain conditions and requires an instrument of insurance, surety bond or self-insurance prior to the testing of a vehicle. Directs the Department of Highway Safety and Motor Vehicles to prepare a report recommending additional legislative or regulatory action that may be required for the safe testing and operation of vehicles equipped with autonomous technology, to be submitted no later than Feb. 12, 2014.
Florida	HB 599 (2012)	The relevant portions of this bill are identical to the substitute version of HB 1207.
Florida	HB 7027 (2016)	Permits operation of autonomous vehicles on public roads by individuals with a valid driver license. This bill eliminates the requirement that the vehicle operation is being done for testing purposes and removes a number of provisions related to vehicle operation for testing purposes. Eliminates the requirement that a driver be present in the vehicle. Requires autonomous vehicles meet applicable federal safety standards and regulations.
Florida	HB 7061 (2016)	Defines autonomous technology and driver-assistive truck platooning technology. Requires a study on the use and safe operation of driver-assistive truck platooning technology and allows for a pilot project upon conclusion of the study.

TABLE
(Continued)

State	Bill Number	Relevant Provisions
Georgia	HB 472 (2017)	Specifies that the law prohibiting following too closely does not apply to the non-leading vehicle in a coordinated platoon. Defines coordinated platoon as a group of motor vehicles traveling in the same lane utilizing vehicle-to-vehicle communication technology to automatically coordinate the movement of the vehicles.
Georgia	SB 219 (2017)	Defines automated driving system, dynamic driving task, fully autonomous vehicle, minimal risk condition and operational design domain. Exempts a person operating an automated motor vehicle with the automated driving system engaged from the requirement to hold a driver's license. Specifies conditions that must be met for a vehicle to operate without a human driver present in the vehicle, including insurance and registration requirements.
Louisiana	HB 1143 (2016)	Defines "autonomous technology" for purposes of the Highway Regulatory Act.
Michigan	SB 995 (2016)	Allows for autonomous vehicles under certain conditions. Allows operation without a person in the autonomous vehicle. Specifies that the requirement that commercial vehicles maintain a minimum following distance of 500 feet does not apply to vehicles in a platoon.
Michigan	SB 996 (2016)	Allows for autonomous vehicles under certain conditions. Allows operation without a person in the autonomous vehicle.
Michigan	SB 997 (2016)	Defines automated driving system. Allows for the creation of mobility research centers where automated technology can be tested. Provides immunity for automated technology manufacturers when modifications are made without the manufacturer's consent.
Michigan	SB 998 (2016)	Exempts mechanics and repair shops from liability on fixing automated vehicles.
Michigan	SB 169 (2013)	Defines "automated technology," "automated vehicle," "automated mode," expressly permits testing of automated vehicles by certain parties under certain conditions, defines operator, addresses liability of the original manufacturer of a vehicle on which a third party has installed an automated system, directs state DOT with Secretary of State to submit report by Feb. 1, 2016.
Michigan	SB 663 (2013)	Limits liability of vehicle manufacturer or upfitter for damages in a product liability suit resulting from modifications made by a third party to an automated vehicle or automated vehicle technology under certain circumstances; relates to automated mode conversions.
Nevada	AB 511 (2011)	Authorizes operation of autonomous vehicles and a driver's license endorsement for operators of autonomous vehicles. Defines "autonomous vehicle" and directs state Department of Motor Vehicles (DMV) to adopt rules for license endorsement and for operation, including insurance, safety standards and testing.
Nevada	SB 140 (2011)	Prohibits the use of cell phones or other handheld wireless communications devices while driving in certain circumstances, and makes it a crime to text or read data on a cellular phone while driving. Permits use of such devices for persons in a legally operating autonomous vehicle. These persons are deemed not to be operating a motor vehicle for the purposes of this law.
Nevada	SB 313 (2013)	Relates to autonomous vehicles. Requires an autonomous vehicle that is being tested on a highway to meet certain conditions relating to a human operator. Requires proof of insurance. Prohibits an autonomous vehicle from being registered in the state, or tested or operated on a highway within the state, unless it meets certain conditions. Provides that the manufacturer of a vehicle that has been converted to be an autonomous vehicle by a third party is immune from liability for certain injuries.
Nevada	AB 69 (2017)	Defines terms including "driver-assistive platooning technology," "fully autonomous vehicle" and "automated driving system." Allows the use of driver-assistive platooning technology on highways in the state. Preempts local regulation. Requires the reporting of any crashes to the department of motor vehicles within 10 days if the crash results in personal injury or property damage greater than \$750. Allows a fine of up to \$2,500 to be imposed for violations of laws and regulations relating to autonomous vehicles. Permits the operation of fully autonomous vehicles in the state without a human operator in the vehicle. Specifies that the original manufacturer is not liable for damages if a vehicle has been modified by an unauthorized third party. Allows the DMV to adopt certain regulations relating to autonomous vehicles. Defines "driver," for purposes of an autonomous vehicle, to be the person who causes the automated driving system to engage. Specifies that the following distance requirement does not apply to a vehicle using platooning technology. Imposes an excise tax on the connection of a passenger to a fully autonomous vehicle for the purpose of providing transportation services. Specifies requirements for autonomous vehicle network companies, including a permitting requirement, prohibitions on discrimination, and addressing accessibility. Permits the use of autonomous vehicles by motor carriers and taxi companies if certain requirements are met.

TABLE
(Continued)

State	Bill Number	Relevant Provisions
New York	SB 2005 (2017)	Allows the commissioner of motor vehicles to approve autonomous vehicle tests and demonstrations. Requires supervision from the state police for testing. Specifies requirements for operation, including insurance of five million dollars. Defines autonomous vehicle technology and dynamic driving task. Requires a report on testing and demonstration.
North Carolina	HB 469 (2017)	Establishes regulations for the operation of fully autonomous motor vehicles on public highways of this state. Defines terms. Specifies that a driver's license is not required for an AV operator. Requires an adult be in the vehicle if a person under 12 is in the vehicle. Preempts local regulation. Establishes the Fully Autonomous Vehicle Committee.
North Carolina	HB 716 (2017)	Modifies the follow-too-closely law to allow platooning.
North Dakota	HB 1065 (2015)	Provides for a study of autonomous vehicles. Includes research into the degree that automated motor vehicles could reduce traffic fatalities and crashes by reducing or eliminating driver error and the degree that automated motor vehicles could reduce congestion and improve fuel economy.
North Dakota	HB 1202 (2017)	Requires the department of transportation to study the use of vehicles equipped with automated driving systems on the highways in this state and the data or information stored or gathered by the use of those vehicles. Also requires that the study include a review of current laws dealing with licensing, registration, insurance, data ownership and use, and inspection and how they should apply to vehicles equipped with automated driving systems.
Pennsylvania	SB 1267 (2016)	Allows the use of allocated funds, up to \$40,000,000, for intelligent transportation system applications, such as autonomous and connected vehicle-related technology, in addition to other specified uses.
South Carolina	HB 3289 (2017)	Specifies that minimum following distance laws for vehicles traveling along a highway do not apply to the operator of any non-leading vehicle traveling in a platoon.
Tennessee	SB 598 (2015)	Relates to motor vehicles. Prohibits local governments from banning the use of motor vehicles equipped with autonomous technology.
Tennessee	SB 2333 (2016)	Allows a motor vehicle to be operated, or to be equipped with, an integrated electronic display visible to the operator while the motor vehicle's autonomous technology is engaged.
Tennessee	SB 1561 (2016)	Redefines "autonomous technology" for purposes of preemption. Defines "driving mode" and "dynamic driving task."
Tennessee	SB 676 (2017)	Permits the operation of a platoon on streets and highways in the state after the person provides notification to the department of transportation and the department of safety.
Tennessee	SB 151 (2017)	Creates the "Automated Vehicles Act." Defines a number of terms. Modifies laws related to unattended motor vehicles, child passenger restraint systems, seat belts, and crash reporting in order to address ADS-operated vehicles. Specifies that ADS-operated vehicles are exempt from licensing requirements. Permits ADS-operated vehicles on streets and highways in the state without a driver in the vehicle if it meets certain conditions. Preempts local regulation of ADS-operated vehicles. Specifies that the ADS shall be considered a driver for liability purposes when it is fully engaged and operated properly. Makes it a class A misdemeanor to operate a motor vehicle on public roads in the states without a human driver in the driver's seat without meeting the requirements of this Act. Specifies that this Act only applies to vehicles in high or full automation mode.
Texas	HB 1791 (2017)	Allows the use of a connected braking system in order to maintain the appropriate distance between vehicles. Specifies that "connected braking system" means a system by which the braking of one vehicle is electronically coordinated with the braking system of a following vehicle.
Texas	SB 2205 (2017)	Defines a number of terms, including "automated driving system," "automated motor vehicle," "entire dynamic driving task" and "human operator." Preempts local regulation of automated motor vehicles and automated driving systems. Specifies that the owner of an automated driving system is the operator of the vehicle when the system is engaged and the system is considered licensed to operate the vehicle. Allows an automated motor vehicle to operate in the state regardless of whether a human operator is present in the vehicle, as long as certain requirements are met.

TABLE
(Continued)

State	Bill Number	Relevant Provisions
Utah	HB 373 (2015)	Authorizes the Department of Transportation to conduct a connected vehicle technology testing program.
Utah	HB 280 (2016)	Requires a study related to autonomous vehicles, including evaluating NHTSA and AAMVA standards and best practices, evaluating appropriate safety features and regulatory strategies and developing recommendations.
Virginia	HB 454 (2016)	Allows the viewing of a visual display while a vehicle is being operated autonomously.
Vermont	HB 494 (2017)	Requires the department of transportation convene a meeting of stakeholders with expertise on a range of topics related to automated vehicles. The secretary of transportation must report to the House and Senate committees on transportation regarding the meetings and any recommendations related automated vehicles, including proposed legislation.
Washington, D.C.	2012 DC B 19-0931	Defines “autonomous vehicle” as “a vehicle capable of navigating District roadways and interpreting traffic-control devices without a driver actively operating any of the vehicle’s control systems.” Requires a human driver “prepared to take control of the autonomous vehicle at any moment.” Restricts conversion to recent vehicles, and addresses liability of the original manufacturer of a converted vehicle.

Executive Orders

State	Date	Relevant Provisions
Arizona	August 2015	Directs various agencies to “undertake any necessary steps to support the testing and operation of self-driving vehicles on public roads within Arizona.” Orders the enabling of pilot programs at selected universities and developed rules to be followed by the programs. Establishes a Self-Driving Vehicle Oversight Committee within the governor’s office
Massachusetts	October 2016	“To Promote the Testing and Deployment of Highly Automated Driving Technologies.” The order created a working group on AVs and the group is expected to work with experts on vehicle safety and automation, work with members of the legislature on proposed legislation, and support agreements that AV companies will enter with the state DOT, municipalities and state agencies.
Washington	June 2017	To address autonomous vehicle testing and establish an autonomous vehicle work group. The order requires that state agencies with pertinent regulator jurisdiction “support the safe testing and operation of autonomous vehicles on Washington’s public roads.” It establishes an interagency work group and enables pilot programs throughout the state. The order specifies certain requirements for vehicles operated with human operators present in the vehicle and for vehicles operated without human operators in the vehicle.
Wisconsin	May 2017	Creates the Governor’s Steering Committee on Autonomous and Connected Vehicle Testing and Deployment. The committee is tasked with advising the governor “on how best to advance the testing and operation of autonomous and connected vehicles in the State of Wisconsin.” The order specifies the members of the committee, including six legislators from the state. The duties of the committee include 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. The state department of transportation is required to submit a final report to the governor by June 30, 2018.

Draft Concept Language for the State of Indiana

A Bill for an Act to Amend Indiana Code Concerning Truck Platoons

Section 9-21-8 is amended to read as follows:

9-21-8-0.6 “Truck platoon”

Sec. 0.6. As used in this chapter, “truck platoon” means a group of individual motor trucks, motor trucks drawing other vehicles, or tractor-trailer combinations that are traveling in a unified manner at electronically coordinated speeds.

Section 9-21-8-15 is amended to read as follows:

Sec. 9-21-8-15

(a) Except when overtaking and passing, a person who drives a motor truck, motor truck drawing another vehicle, or tractor-trailer combination, when traveling upon a roadway outside of a business or residence district or upon a roadway that is a part of the interstate highway system, whether within or without a business or residence district, may not follow within three hundred (300) feet of another motor truck, motor truck drawing another vehicle, or a tractor-trailer combination.

(b) The provisions of this section shall not apply to a truck platoon, so long as an appropriately endorsed driver who holds a valid commercial driver’s license is present behind the wheel of each truck in the platoon.

APPENDIX D: CURRENT LEGISLATION IN INDIANA

Current Indiana Legislation Related to Following Distances

Source: Indiana General Assembly (2017, July). Indiana Code. <http://iga.in.gov/legislative/laws/2017/ic/titles/009#9-21-8-14>

IC 9-21-8-14 Following other vehicles; distance restrictions

Sec. 14. A person who drives a motor vehicle may not follow another vehicle more closely than is reasonable and prudent, having due regard for the speed of both vehicles, the time interval between vehicles, and the condition of the highway.

[Pre-1991 Recodification Citation: 9-4-1-73(a).]

As added by P.L.2-1991, SEC.9.

IC 9-21-8-15 Trucks and tractor-trailers; following other trucks; distance restrictions

Sec. 15. Except when overtaking and passing, a person who drives a motor truck, motor truck drawing another vehicle, or tractor-trailer combination, when traveling upon a roadway outside of a business or residence district or upon a roadway that is a part of the interstate highway system, whether within or without a business or residence district, may not follow within three hundred (300) feet of another motor truck, motor truck drawing another vehicle, or a tractor-trailer combination.

[Pre-1991 Recodification Citation: 9-4-1-73(b).]

As added by P.L.2-1991, SEC.9.

IC 9-21-8-16 Caravans and motorcades; distance between vehicles; exceptions

Sec. 16. (a) This section does not apply to funeral or marching band processions.

(b) Motor vehicles being driven upon a roadway outside of a business or residence district in a caravan or motorcade, whether or not towing other vehicles,

must be operated to allow sufficient space between each vehicle or combination of vehicles to enable another vehicle to enter and occupy the space without danger.

[Pre-1991 Recodification Citation: 9-4-1-73(c).]

As added by P.L.2-1991, SEC.9.

Current Indiana Legislation Related to Cell Phone Use

Source: Indiana General Assembly (2017, July). Indiana Code. <http://iga.in.gov/legislative/laws/2017/ic/titles/009#9-21-8-59>

IC 9-21-8-59 Use of telecommunications device while operating a moving motor vehicle

Sec. 59. (a) A person may not use a telecommunications device to:

(1) type a text message or an electronic mail message;

(2) transmit a text message or an electronic mail message; or

(3) read a text message or an electronic mail message; while operating a moving motor vehicle unless the device is used in conjunction with hands free or voice operated technology, or unless the device is used to call 911 to report a bona fide emergency.

(b) A police officer may not, without the consent of the person:

(1) confiscate a telecommunications device for the purpose of determining compliance with this section;

(2) confiscate a telecommunications device and retain it as evidence pending trial for a violation of this section; or

(3) extract or otherwise download information from a telecommunications device for a violation of this section unless:

(A) the police officer has probable cause to believe that the telecommunications device has been used in the commission of a crime;

(B) the information is extracted or otherwise downloaded under a valid search warrant; or

(C) otherwise authorized by law.

As added by P.L.185-2011, SEC.4. Amended by P.L.191-2014, SEC.1.

APPENDIX E: SAMPLE DATA FROM COMPANIES TESTING AUTONOMOUS VEHICLES IN CALIFORNIA

Source: California DMV (2017). Autonomous Vehicles in California. <https://www.dmv.ca.gov/portal/dmv/detail/vr/autonomous/bkgd>.

California has developed a protocol for testing and deployment of driverless and automated vehicles. The AV program was proposed and a comment period and public hearing were held to obtain input from the public and other stakeholders. Sample forms include the following.

- Autonomous Vehicle Testing (AVT) Program Application for Manufacturer Testing Permit
- Autonomous Vehicle Testing (AVT) Program Application for Manufacturer Testing Permit for Driverless Vehicle
- AVT Program Application for Certificate of Self-Insurance
- Autonomous Vehicle Deployment Permit Application for Certificate of Self-Insurance
- Report of Collision involving an AV
- Application for Permit to Deploy AV on Public Streets

TABLE E.1
Companies Issued AV Testing Permits by the California DMV (as of June 27, 2017)

Volkswagen Group of America	Telenav, Inc.
Mercedes Benz	NVIDIA Corporation
Waymo	AutoX Technologies Inc
Delphi Automotive	Subaru
Tesla Motors	Udacity, Inc
Bosch	Navya Inc.
Nissan	Renovo.auto
GM Cruise LLC	UATC LLC (Uber)
BMW	PlusAi Inc
Honda	Nuro, Inc
Ford	CarOne LLC
Zoox, Inc.	Apple Inc.
Drive.ai, Inc.	Bauer's Intelligent Transportation
Faraday & Future Inc.	Pony.AI
Baidu USA LLC	TuSimple
Wheego Electric Cars Inc.	Jingchi Corp
Valeo North America, Inc.	SAIC Innovation Center, LLC
NextEV USA, Inc.	Almotive Inc

Disengagement Reports for Companies Testing AV in California

California requires automated vehicle operators to provide data anytime the autonomous vehicle disengages

TABLE E.2
Sample Companies Providing AV Disengagement Data Reports to California

Manufacturers	Years
BMW	2016
Bosch, LLC	2015, 2016
GM Cruise	2016
Delphi Automotive Systems, LLC	2015, 2016
Ford	2016
Google Auto, LLC/Waymo	2015, 2016
Honda	2016
Nissan North America, Inc.	2015, 2016
Mercedes-Benz Research & Development North America, Inc.	2015, 2016
Tesla Motors, Inc.	2015, 2016
Volkswagen Group of America, Inc.	2015, 2016

from autonomous mode. This may include both automatic and manual disengagements and disengagements may be unplanned or planned for testing purposes. Below are excerpts of sample data provided by companies operating in California in 2016 and 2015.

Time to Transition to Manual Control

The time required to transition to manual control from automated control ranged from 0.1 s (Google, 2015) to 4.4 s (Tesla, 2016). Tesla clarified that the time to take over was calculated as the time between an alert and the first measured driver input, noting that this may exceed the time between the alert and the driver assuming manual control, especially on a straight road.

Accident Reports

Accident Reports involving AV are publicly available (with redacted information) in California. Thirty-four accident reports have been filed as of July 14, 2017. The first accident report was filed in October, 2014.

Accidents include a wide variety of circumstances from injury crashes with bicyclists while on autonomous mode (GM Cruise, 2017) to single vehicle crashes on conventional mode (Google, 2017), and crashes in which the AV is hit by other vehicles while it is autonomous mode (Google, 2017), even at very low speeds.

TABLE E.3
Sample Data for AV Testing in California

Company, year	Autonomous miles	Reportable disengages	Disengagements per 1,000 miles
Google, 2015	424,331	341	0.80
Google, 2016	635,868	124	0.20
BMW, 2016	638	1	1.57
Mercedes Benz, 2016	673	336	498.95
GM Cruise, 2016	9,730	149	124.32

TABLE E.4
Sample Reasons for Disengagements in 2016

Company	Sample Reasons for Disengagement	Comments
Google	Software discrepancy (51/124) Unwanted maneuver of vehicle (30/124) Perception discrepancy (20/124)	Google had 59 vehicles tested. Sample locations during planned testing included highway (12/124) and street (112/124); none occurred on freeways or interstates.
BMW	Operator disengaged because lane markings were not clear enough to detect the lane	
Tesla	Follower output invalid Planner output invalid Health monitor Cruise Fault	Disengagement often occurred on a wet road. Road class often indicated as unknown.
GM Cruise	Planned test	

TABLE E.5
AV Accident Reports Filed in California (as of July 14, 2017)

Year	Company	Number of accident reports
2017	GM Cruise	7
2017	Google	2
2016	Google	13
2016	Nissan	1
2016	Cruise Automation	1
2015	Google	9
2014	Delphi	1

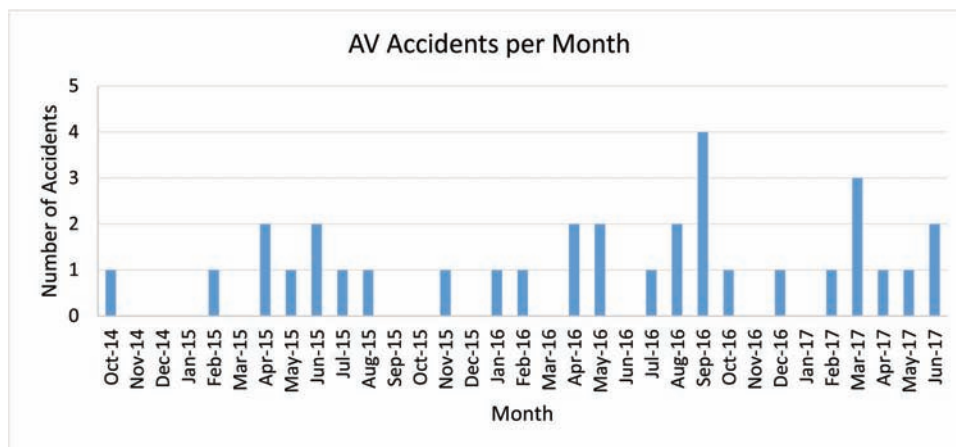


Figure E.1 AV accidents per month reported in California.

About the Joint Transportation Research Program (JTRP)

On March 11, 1937, the Indiana Legislature passed an act which authorized the Indiana State Highway Commission to cooperate with and assist Purdue University in developing the best methods of improving and maintaining the highways of the state and the respective counties thereof. That collaborative effort was called the Joint Highway Research Project (JHRP). In 1997 the collaborative venture was renamed as the Joint Transportation Research Program (JTRP) to reflect the state and national efforts to integrate the management and operation of various transportation modes.

The first studies of JHRP were concerned with Test Road No. 1—evaluation of the weathering characteristics of stabilized materials. After World War II, the JHRP program grew substantially and was regularly producing technical reports. Over 1,600 technical reports are now available, published as part of the JHRP and subsequently JTRP collaborative venture between Purdue University and what is now the Indiana Department of Transportation.

Free online access to all reports is provided through a unique collaboration between JTRP and Purdue Libraries. These are available at: <http://docs.lib.purdue.edu/jtrp>

Further information about JTRP and its current research program is available at: <http://www.purdue.edu/jtrp>

About This Report

An open access version of this publication is available online. This can be most easily located using the Digital Object Identifier (doi) listed below. Pre-2011 publications that include color illustrations are available online in color but are printed only in grayscale.

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