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Federal, State, and Local Governance of Automated Vehicles

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SUMMARY

Automated vehicles (AVs) bring the possibility for direct and expansive societal benefits. They could improve mobility for the elderly, disabled, and underserved individuals, expand access to jobs and health care, ease congestion, and improve fuel economy. But without appropriate governance structures and policies, rapid deployment of AVs could actually worsen our transportation problems.[1]

The current policy environment is ill-prepared for AVs. Federal, state, and local governments are scrambling to catch up to the technology. Legislators at the federal and state level are introducing and passing laws around these vehicles that are still in the early stages of development. Collaboration is needed between the local and private sectors to put forward data-driven policies that support the safe and effective operation of AVs.

With such collaboration in mind, steps must be taken now to ensure that AVs support rather than undermine a diverse slate of societal objectives, including reduced congestion, increased travel choice and equity, reduced emissions, and sustainable funding. Federal policy will need to preserve the authority of states, regions, and cities as well as other stakeholders to pursue their own goals. Local governments play a critical role in the safe and effective deployment of AVs. Any preemptive[2] language should be avoided or crafted so that unintended liabilities are not passed to municipalities, especially when minimum safety standards for AVs are far from development and roads lack design standards that support AV deployment. Federal policy will also need to support interoperability of AVs and AV infrastructure across governance and infrastructure boundaries.

There are many specific policy options that can help address challenges associated with AVs. The key, though, is to implement policy frameworks that support cities and states in achieving their goals and can be adjusted in response to observed consequences while still providing enough structure for the AV sector to mature responsibly.

There are three key principles that should underlie the establishment of such frameworks:

1. Empower local and state governments while minimizing regulatory patchworks and treading lightly around use of preemption.

1 Sperling, *Three Revolutions: Steering Automated, Shared, and Electric Vehicles to a Better Future.*

2 Generally, three types of preemption are recognized: express, field, and conflict preemption. Express preemption occurs when a statute has clear language providing that the law is intended to supersede related state or local laws. Field preemption can exist when the government, without any express declaration in an enacted law, legislates in a way that is so comprehensive as to occupy the entire "field" of a topic. Conflict preemption is recognized when either (i) it is impossible for someone to comply with both state and federal laws, or (ii) when the purposes and objectives of federal law would be thwarted by state law. Since there are no federal safety standards for AVs, there is uncertainty around whether there is an argument for conflict preemption. There is also uncertainty around whether a claim of field preemption would prevail since the U.S. Department of Transportation has issued federal guidance on AV policy. In other words, the issue of preemption is complicated and challenging and very untested when it comes to AV regulation.

2. Prioritize continuous improvement in AV safety with public outreach and education in mind.
3. Encourage collection and sharing of AV data while protecting consumer privacy and respecting proprietary considerations.

This paper describes needs and recommends actions for AV governance at the federal, state, and local levels. It updates and builds on a previous policy brief from the 3 Revolutions Future Mobility Program at UC Davis titled "Governance: Who's in Charge here?" (February 2017).

The paper is organized into five sections:

- Section I describes the broader context in which AV governance issues exist;
- Section II describes the federal, state, and local policy landscape for AVs;
- Section III identifies key governance challenges;
- Section IV provides policy recommendations; and
- Section V concludes.

I. INTRODUCTION

The advent of automated vehicles (AVs) is challenging traditional governance structures. New legislation, regulation, and guidance is needed to unlock the maximum societal benefits that AV technology can offer while avoiding adverse consequences.

This paper focuses on governance issues related to AV safety and operation. It should be recognized that other governance issues, such as those related to possible societal and environmental impacts of AV technology, are equally pressing. The 3 Revolutions Future Mobility (3Rs) Program at UC Davis[3] has developed a series of policy briefs and other resources on a variety of topics such as the potential impacts of AVs on congestion, urban sprawl, labor, pollution, and greenhouse gas emissions.

Initial movement on AV governance is occurring on several fronts. The U.S. Department of Transportation (USDOT), through the National Highway Traffic Safety Administration (NHTSA), has released multiple versions of voluntary guidelines concerning AV deployment on public roads.[4] The U.S. House of Representatives passed H.R. 3388, the ''Safely Ensuring Lives Future Deployment and Research In Vehicle Evolution Act'' (SELF-DRIVE Act), in September 2017.[5] The U.S. Senate passed a related bill—S. 1885, the "American Vision for Safer Transportation Through Advancement of Revolutionary Technologies" (AV START Act)—out of committee in November 2017.[6] As of the publication of this paper, S. 1885 has not yet passed the full Senate due to concerns around minimum safety requirements for AVs and indefinite preemption of state and local laws. At the sub-national level, 29 states plus the District of Columbia have enacted formal AV-related policies, and 8 governors have issued AV-related executive orders. Maine, Washington and Wisconsin have taken both legislative and executive action (Figure 1).[7]

3 UC Davis Institute of Transportation Studies & Policy Institute for Energy, the Environment, and the Economy, "The 3 Revolutions Future Mobility Program."
4 National Highway Traffic Safety Administration, "U.S. DOT Releases New Automated Driving Systems Guidance."
5 U.S. Congress, House, *Safely Ensuring Lives Future Deployment and Research in Vehicle Evolution Act (SELF DRIVE Act)*, H.R. 3388.
6 U.S. Congress, Senate, *American Vision for Safer Transportation through Advancement of Revolutionary Technologies Act (AV START Act)*, S. 1885.
7 National Conference of State Legislatures, "Autonomous Vehicles Self-Driving Vehicles Enacted Legislation."

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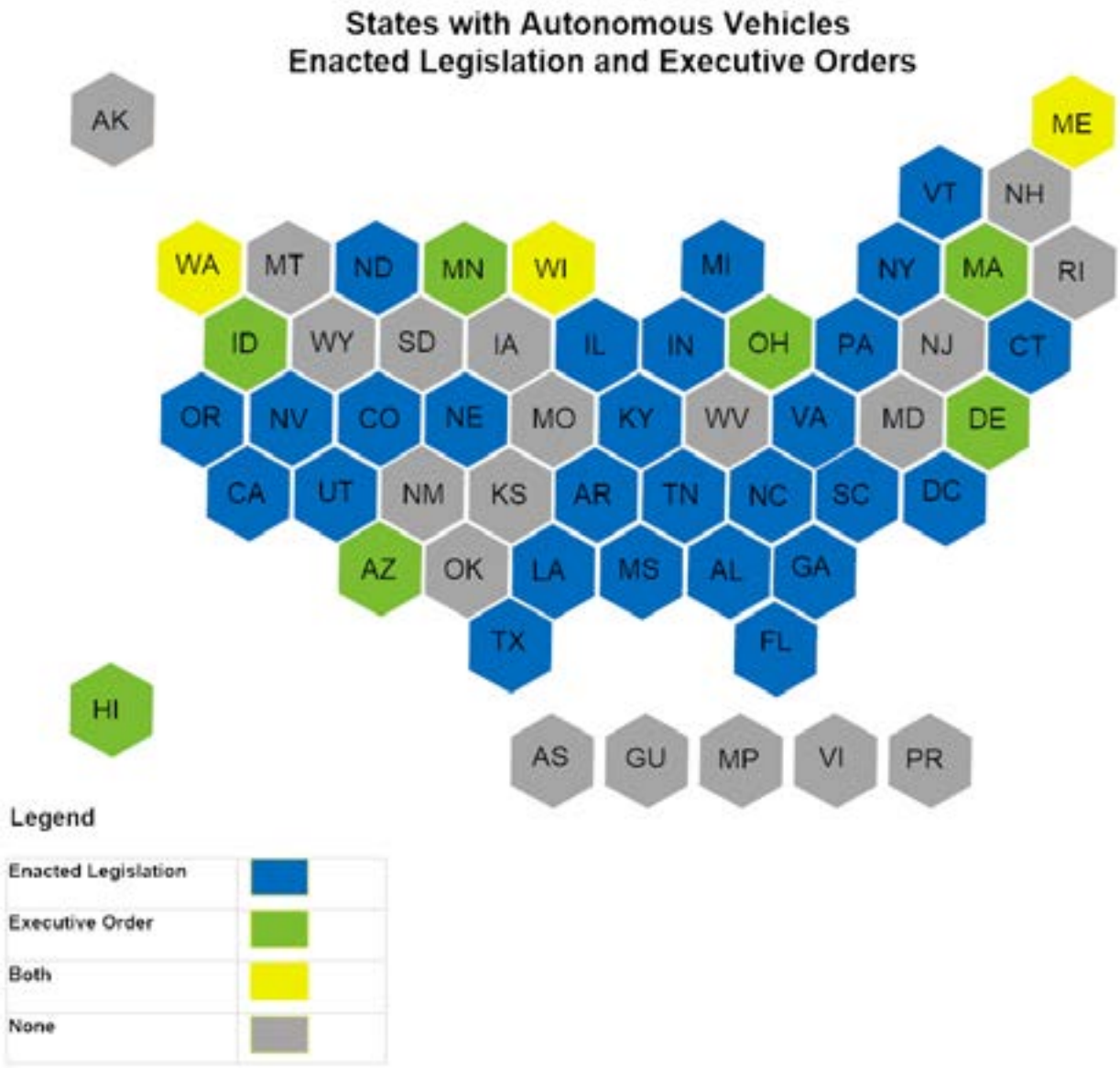

Figure 1. *The National Conference of State Legislatures (NCSL) maintains a searchable database containing frequently updated information about the status of state-level AV legislation across the country. As of October 18, 2018, 29 states plus the District of Columbia have passed AV-related legislation and an additional 10 have issued AV-related executive orders.*

These actions, while promising, fall short of providing a robust governance structure or meeting all policy needs for AV deployment. Federal, state, and local roles must become clearer to streamline regulation and permitting. State and local governments should be able to tailor AV policies around land use, zoning, and public rights-of-way to ensure the safety of citizens. Infrastructure design specifications (i.e., for roads, crosswalks, and sidewalks) as well as safety standards and liability frameworks require updating to reflect the unique capabilities and requirements of AVs. In particular, replacing design-based standards with performance-based standards will protect the public and instill confidence in AV technology.[8] Furthermore, collection and sharing of data is essential for ensuring that

8 Claybrook and Kildare, "Autonomous vehicles: No driver...no regulation?"

current and future regulatory needs are met and can be justified.[9]

Such changes must happen soon, but also need to be flexible to allow for refinement as AV technology continues to develop. Without concrete policies regulating AV deployment, unverified technology may enter public roads and put lives at risk.[10] Unclear division of responsibilities and authorities among federal, state, and local agencies will hamper AV development, making it more difficult to realize the benefits that AVs offer and creating unintended liabilities for states and local governments. Lack of data sharing on AV tests, performance, and failures could slow improvements to and public acceptance of AV technology.[11] Technologies should be deployed with appropriate rules and pricing for use of public infrastructure. It will be much more challenging to add policies once they are perceived as "free". Further, new issues that come with AV technology—such as protection of consumer data, data-supported planning, and coordination with law enforcement—need to be integrated into policies. Proactive steps at the federal, state, and local levels will minimize safety risks and other adverse impacts while fostering innovation and societal benefits.

II. FEDERAL, STATE, AND LOCAL POLICY LANDSCAPE FOR AVS

This section provides an overview of the current federal, state, and local policy landscape for AVs.

FEDERAL GOVERNANCE

The USDOT, through NHTSA, is the primary U.S. federal authority with jurisdiction over vehicle safety. The USDOT can set standards for vehicle performance and design features and can recall vehicles if a safety defect is detected. NHTSA specifies and regulates certain safety-related vehicle features through the Federal Motor Vehicle Safety Standards (FMVSS) and coordinates with the U.S. Environmental Protection Agency (EPA) to set corporate average fuel economy (CAFE) standards. The USDOT is the major funder for road and transit projects, as well as a major source of funding for transportation research and development. This role gives the agency additional influence in shaping the evolution of AV technologies and markets.

Despite these authorities, the USDOT's governance of AVs has to date been limited to issuing voluntary guidelines on AV development and deployment. The USDOT's most recent guidance document was issued in October 2018. Titled *Preparing for the Future of Transportation; Automated Vehicles 3.0*, the most recent guidance has major themes that are unchanged from previous versions. The USDOT continues to stress its commitment to technology-neutral policy. The USDOT also continues to emphasize safety as a top priority, although Version 3.0 of the guidance—in pledging to "protect freedoms enjoyed by Americans"—delegates much responsibility for ensuring AV safety to AV manufacturers through self-certifications.[12]

Version 3.0 of the guidance also reiterates and updates concepts from previous versions. For example, Version 3.0 reiterates that the terms "driver" and "operator" do not refer exclusively to a human and could refer to an automated system.[13] It updates AV considerations for local governments to include how vehicles may affect land use, including curb space designated for pick-up and drop-off activities and parking lots repurposed for community-centric activities. The new version of the guidance also addresses some new facets of vehicle automation. While previous versions of the guidance were limited to passenger vehicles, Version 3.0 seeks to expand AV guidance to apply to additional transportation modes, including commercial trucks and public transit. The guidance states that the USDOT seeks to develop a national pilot program for testing AVs across the country.[14]

9 *Ibid.*
10 *Ibid.*
11 *Ibid.*
12 U.S. Department of Transportation, Automated Vehicles 3.0 Activities.
13 *Ibid.*
14 *Ibid.*

It also states that the USDOT is willing to explore streamlining changes to the FMVSS that will be needed to support a driverless future—a future in which vehicle components such as steering wheels and brake pedals may be unnecessary and vehicle interiors can be completely redesigned. Finally, AV Version 3.0 suggests that preparing for AVs will be a multimodal effort that will need to include a whole host of stakeholders and wide consumer education. Through statements such as the following, the guidance recognizes the possible societal long-term effects of AV technology:

> *There is uncertainty around how automation will change travel behavior, land use, and public revenues across the transportation landscape in the long term. State and local* ***policymakers must wrestle with the effects of automation*** *when conducting long-term transportation planning.*[15]

It is unclear how, or if, planning agencies will take statements like these into consideration, but the USDOT's mention of societal impacts is a significant step in the right direction.[16]

The U.S. Congress has recently responded to calls for action from the private sector and increased its involvement in AV governance. The Senate and the House of Representatives have held multiple hearings on AVs.[17] The House of Representatives passed H.R. 3388, the SELF-DRIVE Act, in September 2017. S. 1885, the AV START Act has not yet passed the full Senate due to concerns around minimum safety requirements for AVs, consumer rights, and preemption of state and local laws. The SELF-DRIVE Act and the AV START Act both include provisions to:

- Preempt the actions of state and local governments in regulating the "design, construction, or performance[18] of a high automated vehicle or automated driving systems" on roadways.
- Increase limits on the number of FMVSS exemptions that automakers are allowed.[19] Specifically, the Senate (S) and House (H) versions increase the number to 15,000(S)/25,000(H) vehicles within the first year to 80,000(S)/100,000(H) vehicles after four years to unlimited vehicles after that.
- Expedite processes for updating the FMVSS to incorporate highly automated vehicles (HAVs).
- Make currently voluntary safety assessment reports mandatory under USDOT guidance.
- Rule out pre-market approval that would require USDOT testing of every AV model before being sold.
- Encourage development of consistent frameworks for AV testing, data collection, and result sharing.
- Require studies on HAV accessibility for elderly, disabled, and underserved populations.

STATE GOVERNANCE

State governments oversee driver licensing, vehicle registration, insurance requirements, vehicle inspections, and traffic laws to ensure safety. States also have a significant role in funding and constructing transportation projects. There is considerable variability in how states have exercised these powers with respect to AVs.

Some states have been relatively quick to approve and regulate AVs. These policies include a variety of approaches,

15 *Ibid.*

16 *Ibid.*

17 See, for instance "Hands Off: The Future of Self-Driving Cars" (March 15, 2016), a hearing convened by Senator John Thune, and "Self-Driving Vehicle Legislation" (June 27, 2017), a hearing convened by Representative Robert Latta.

18 Negotiations of the AV Start Act have included clarifying the definition of "performance", which is necessary to clarify NHTSA's jurisdiction over the design of the vehicle itself, rather than its operational domain. Without such clarification, undefined broad preemption provisions may limit the ability for local governments to implement potential new fee models, such as congestion and curb pricing. These fee models are being considered and evaluated in many jurisdictions to not only generate needed infrastructure revenue, but also balance the expected negative revenue impacts to cities from AVs, particularly parking.

19 The FMVSS require vehicles sold to have certain safety features that meet certain standards (such as brake pedals, mirrors, and steering). Automakers can currently request waivers for up to 2,500 vehicles per year to test new technology or deploy niche vehicles. USDOT reports to Congress on waivers requested and granted. Manufacturers requesting an exemption are required to certify that their exempted vehicle would be as safe as or safer than compliant vehicles.

illustrating that there is no "one-size-fits-all" way to govern AVs. In 2011, Nevada and Florida became the first states to authorize AV operation.[20] In 2012, California passed Senate Bill (SB) 1298, which required the California Department of Motor Vehicles (DMV) to develop rules for AV operation.[21] The resulting regulation went into effect in April 2018. California's AV policy is currently the most far-reaching in the United States. California's policy requires companies seeking to test AVs to apply for permits from the State. California also allows for "remote" testing without a driver or operator in the vehicle so long as a permit has been obtained and a law enforcement interaction plan has been submitted. Finally, California requires AV testing companies operating in California to document and report miles driven as well as the number of times when a human driver, when present, had to retake control of the vehicle.[22]

A few states have enacted legislation aimed at clarifying state and local authorities regarding AV governance. In 2015, Tennessee passed SB 598, which prohibits local governments from banning AVs on local roads so long as the vehicle meets all safety regulations required of the political subdivision.[23] In 2017, Illinois passed a similar law (HR 791) that restricts local governments from prohibiting AV use on local roads.[24]

Other states have been more conservative in their policy approaches. Much state action on AVs to date focuses relatively narrowly on platooning for automated trucks. Other state action simply calls for further study on AVs to inform future governance. States including Connecticut, Maine, Massachusetts, Minnesota, North Dakota, and Oregon have issued legislative or executive direction establishing AV advisory task forces, commissions, and/or studies.[25] The remaining states that currently lack AV-related policy (see figure 1) seem to be adopting more of a "wait and see" strategy, likely delaying action due to uncertainty around federal legislation and/or technological maturation.

REGIONAL AND LOCAL GOVERNANCE

Regional and local governments and agencies play many important roles in transportation. They plan, fund, and maintain the use of rights of way within their boundaries; operate public transit; determine parking policy and set street-design guidelines; and facilitate interjurisdictional coordination.

Reductions in federal transportation funding have made regional and local governments and agencies increasingly important. Regions that collaborate to develop new revenue generation strategies will likely be better equipped to handle coming challenges. For instance, the Ohio Department of Transportation is partnering with Smart Columbus and DriveOhio to form a public-private partnership with technology firms for the deployment of AV downtown shuttle service.[26]

The expanding influence of regional and local governments and agencies underscores the importance of issuing state and federal policies to prevent the emergence of a "patchwork" of regulations governing AV operation and infrastructure across governance boundaries, as well as to ensure interoperability of AVs across jurisdictional boundaries. Equally important is involving local stakeholders in policymaking processes to ensure that AV policies can be tailored to regional and local opportunities and needs. Many local governments are launching efforts to achieve the latter. For instance:

20 Newcomb, "Robo Rules: The State of Autonomous Vehicle Regulations."
21 U.S. Congress, Senate, *Vehicles: Autonomous Vehicles: Safety and Performance Requirements.* S. 1298.
22 Karsten and West, "The state of self-driving car laws across the U.S."
23 General Assembly of the State of Tennessee, *An Act to Amend Tennessee Code Annotated.* SB 598.
24 National Conference of State Legislatures, "Autonomous Vehicles State Bill Tracking Database."
25 National Conference of State Legislatures, "Autonomous Vehicles Self-Driving Vehicles Enacted Legislation."
26 Ohio Department of Transportation, "Request for Proposal #505-19 Automated Vehicle Shuttle Service."

Boston, MA, has taken an active approach to regulating AV testing on the local level. In October 2016, Boston Mayor Martin Walsh issued an executive order establishing an AV policy framework for the city that emphasizes electric and shared AVs and sets conditions for AV testing. The framework has increased opportunities for AV deployment and has strengthened relationships between the city and AV automakers.[27]

Beverly Hills, CA, passed a resolution in April 2016 to create an AV program that brings together AV experts in public summits and calls for new partnerships among AV automakers and city agencies. The resolution inspired Beverly Hills Mayor John Mirish to link AV technology and public transportation through an autonomous shuttle system for the Los Angeles Purple Line extension upon its completion in 2026.[28]

Portland, OR, Mayor Ted Wheeler—together with the Portland Commissioner-in-Charge of Transportation and the Portland Bureau of Transportation—,aunched the Smart Autonomous Vehicle Initiative in 2017. The initiative supports AV testing and piloting with a focus on meeting equity, climate change, and economic goals and invites public comments to shape local AV governance.[29]

Recognizing the need to plan for emerging AVs, more local governments are exploring AV pilot projects to better understand how this new technology will interact with local transportation systems. Such pilot and demonstration projects are expected to be supported by federal funding through competitive grants. Regional collaboration will be critical for the development of planning models that consider AV impacts within a region's transportation system. Local and regional agencies will need to work together to update their general plans to support AV deployment in line with the development and growth of a community.

Regional collaboration around policy development to support the safe and effective deployment of AVs, including the development of planning models that consider the deployment of AVs within a region's transportation system, will be critical. With the diversity of transportation needs across the country, it is dangerous and short-sighted to move forward with a one-size-fits-all approach to AV deployment. Instead, public and private collaboration should be focused on developing general plan updates that support the deployment of AVs in coordination with the development and growth of a community.

III. KEY GOVERNANCE CHALLENGES

Recent years have seen progress on AV policy at all levels of government. To build on this progress and ensure effective federal, state, and local governance of rapidly developing AV technologies and systems, several key challenges must be addressed.

AVS REQUIRE UPDATES TO THE FMVSS

Of the 73 federal vehicle safety regulations, half date back to before 1980.[30] Research commissioned by the NHTSA demonstrates that almost half of these regulations create major obstacles for the development and deployment of AVs.[31] Some regulations will need to be updated, some eliminated, and some expanded to accommodate a wide range of new AV models and systems.

HAVs require a way to communicate with pedestrians and cyclists in the absence of a human driver. Regulations governing vehicle lighting systems may need to permit new lighting and signaling configurations that allow for

27 Rogers, "3 Ways that Cities Can Prepare for Automated Vehicles Today."
28 *Ibid.*
29 Portland Bureau of Transportation, "Portland Launches Smart Automotive Vehicles Initiative (SAVI)."
30 Scribner, "Outdated Auto Safety Regulations Threaten the Self-Driving Revolution."
31 *Ibid.*

AVs to communicate with other road users.[32] Adding sensor vision tests to the FMVSS can ensure that AVs are safe before deployment onto multi-use roads. Federal policy defines operational design domain (ODD) as follows:

> *The specific conditions under which a given driving automation system or feature thereof is designed to function, including, but not limited to, driving modes. This can incorporate a variety of limitations, such as those from geography, traffic, speed, and roadways.*[33]

Defining specific ODD parameters would provide clearer guidance to state and local governments on how AVs should operate among other road users. Widespread use of AVs will likely shift transportation infrastructure needs,

calling for smart road infrastructure designed to interact with AVs.[34]

In general, the transition from conventional to automated vehicles calls for a parallel transition from design-based standards that specify the appearance and/or construction of a vehicle to performance-based standards that set safety benchmarks. Some local governments have initiated this transition by launching "Vision Zero" initiatives with a goal of fully eliminating pedestrian fatalities and serious injuries through automated and connected vehicle technology.[35] Further, it is necessary to ensure NHTSA has the powers and resources to continue to issue recalls. With HAVs, this will require the development of standards governing recalls associated with HAV technology, including technology and software, and the use of new verification methods, including potential use of simulations.[36]

Some vehicle components, such as steering wheels, mirrors, and pedals, could be eliminated altogether for HAVs that have a computer system overseeing all driving responsibilities. In addition, human vision tests may no longer be required for some classes of license since disabilities like severe vision impairment may no longer prevent a person from "driving" (i.e., being the sole passenger) in a fully self-driving vehicle.

The challenge is coming up with a new and more efficient process to update regulations, but also ensuring the necessary transparency and opportunity for meaningful public comment.

CONFLICTS OF AUTHORITY CREATES REGULATORY UNCERTAINTY

AVs raise several potential conflicts among federal, state, and regional/local authorities. After NHTSA released its first voluntary guidance, the California DMV issued a proposal that would have made a safety assessment mandatory instead of voluntary by requiring automakers to submit a letter confirming that their technology complies with NHTSA safety guidelines.[37,38] Although the California DMV has since dropped this proposal, it illustrates a circumstance in which a provision could be voluntary at the federal level but mandatory at the state level, potentially conflicting with NHTSA's recognized jurisdiction over vehicle safety. Similarly, California requires that all AVs within its jurisdiction record data 30 seconds before and 5 seconds after an accident, but the NHTSA, through the FMVSS, only requires that pre-accident recording be 5 seconds long.[39]

Regulatory uncertainty leaves AV stakeholders questioning whether they should move forward under existing

32 *Ibid.*
33 U.S. Department of Transportation, *Automated Vehicles 3.0 Activities – Preparing for the Future of Transportation*.
34 Salatiello and Felver, "Current Developments in Autonomous Vehicle Policy in the United States: Federalism's Influence in State and National Regulatory Law and Policy."
35 Kamal, "Fleets Make Streets Safer with Vision Zero Initiative."
36 U.S. Department of Transportation, *Federal Automated Vehicles Policy – Accelerating the Next Revolution in Roadway Safety.*
37 California Department of Motor Vehicles. *Order to Adopt: Testing of Autonomous Vehicles.*
38 Salatiello and Felver, "Current Developments in Autonomous Vehicle Policy in the United States: Federalism's Influence in State and National Regulatory Law and Policy."
39 *Ibid.*

state and local policies or wait indefinitely until national legislation passes. For example, can states require AVs to include certain components (such as accident data recorders) that are not required at the federal level? Will states and localities have the authorities to set limits on topics such as the age of solo HAV occupants, HAV behavior when empty (i.e. whether HAVs must park when empty to limit congestion instead of being allowed to "cruise" streets unrestricted), and fees for different types of HAV-based travel? Such uncertainty slows AV development as stakeholders and planners wait for clearer guidance.

Challenges also arise in coordinating authorities when AV needs span multiple jurisdictions. Counties, cities, and transit agencies will need to work together to develop long-term strategies for incorporating advanced transportation technologies into regional systems. States will need to collaborate to facilitate AV travel across state lines and come to an agreement on how vehicles should behave when operating autonomously (for example, when AVs managed or deployed as part of a commercial fleet are "cruising" in search of passengers). Finally, public utility commissions and other energy agencies will need to work with transportation agencies to ensure that energy grids are able to interact productively with automated electric vehicles.

TRADITIONAL INSURANCE AND LIABILITY FRAMEWORKS ARE INADEQUATE FOR AV DEPLOYMENT

The UC Davis Policy Institute for Energy, Environment, and the Economy is developing a series of policy briefs on AV Insurance and liability. This section summarizes points related to governance issues.

States are responsible for designing their own legal insurance and liability frameworks, which need not align with those of neighboring states. Federal AV law could standardize liability and insurance rules by preempting state laws, but as mentioned before, federal AV laws do not exist. To date, the result has been a patchwork of different AV liability rules and regulations that vary from state to state.

States are in the process of resolving whether, when, and whom to assign liability to in an AV crash. It remains to be seen whether existing legal standards such as negligence or products liability will make sense in an AV context. Driver negligence, the typical legal standard when a conventional vehicle crashes, may not be the best standard for fully self-driving vehicles where human passengers lack control of the vehicle. Products liability, the typical legal standard when a product is improperly designed or assembled, leads to protracted and dense litigation that may be overly costly for passengers involved in a crash. More specialized forms of liability may provide a better solution, but they are comparatively untested in courts.

Furthermore, a state's AV liability framework will only apply to crashes that occur within state lines. If California creates a particular AV liability scheme, it will have no bearing on how Nevada or Oregon address AV liability. This could create problems for AVs that operate across state lines. An AV driver who lives near a state border, for example, could face completely different liability scenarios and burdens depending on which side of the state line the crash occurs.

Any confusion about liability will make litigation less appealing, which will in turn give auto insurers a larger role to play in risk-shifting. All states except New Hampshire require conventional vehicle owners to carry liability insurance.[40] AV operators will likely need liability insurance as well, at least while the transition from partially to fully automated vehicles is still underway. Each state is responsible for setting insurance minimums and approving insurance rates; thus, states will need to account for how AVs will impact the local auto insurance industry. Insurance rates will eventually decline as AVs become mainstream since human error, the major contributor of on-road accidents, will correspondingly decrease. Insurance premiums could drop by as much as 60% in just 15 years.[41] Rate reductions may, however, be offset by the high cost of repairing or replacing advanced AV components.

40 State of New Hampshire Insurance Department, "Your Guide to Understanding Auto Insurance in the Granite State."

41 Buhayar and Robinson, "Can the Insurance Industry Survive Driverless Cars?"

AV liability is further complicated by subscription services from companies like Waymo, Uber, and Lyft.[42] In order to use such services in the current transportation network company space, riders have to agree to terms of use policies. These often limit rider ability to litigate a claim in court in front of a jury and instead require any dispute to be settled through binding arbitration. Such arbitration clauses may limit the ability of riders suffering an injury to seek appropriate recourse. On the other hand, such clauses may provide more predictability around potential damages, keep insurance costs down, and ensure the continued deployment of HAVs. This is an evolving issue that is being debated as part of the bills moving through Congress. The issue of "informed consent" around such terms of use is anticipated to be an issue in future litigation.[43]

DATA COLLECTION, DATA SHARING, AND SOFTWARE UPDATES POSE CHALLENGES

One way to help appropriately assign liability in an AV crash is to use cameras and sensors in AVs to review crash circumstances and support more precise fault determination. Companies like Waymo and Uber have already used data from cameras and sensors to exonerate their AVs and demonstrate that other parties involved were at fault. Better data collection will allow for better pricing of risk since AV models can demonstrate different safety capabilities.

Data sharing among companies deploying AVs could improve industry practices as a whole. Information on incidents such as near misses is valuable training data that can help avoid similar situations in the future. So far, however, most designers of AV systems have been reluctant to share any data that might expose intellectual property. Federal and state governments may wish to require or encourage collection and exchange of key safety-related data to support industry-wide learning. Doing so will require careful navigation of proprietary concerns. Effective data exchange will also require development of exchange frameworks and repositories and exploration of ways to ensure data interoperability.

Beyond safety, there is a pressing need for information on how AVs and other forms of new mobility are affecting transportation systems. Through mutually beneficial partnerships with new mobility providers, states and local governments could gather the information they need without placing undue burdens on industry or becoming overwhelmed by a deluge of new data.

Current vehicle safety standards are designed for vehicles that are built and remain largely unchanged for the duration of their useful lives. By contrast, both partially and fully automated vehicles will rely on software that will likely be frequently updated by the developer, much as computers and phones are today. Regulators will be unable to read every line of code for every update, and unwise to try. Instead, policymakers will need to develop strategies for ongoing monitoring of AV updates. One strategy is to establish protocols for WiFi-enabled "product recalls" of AV software updates in the event that a critical safety or security flaw is identified.

There are also governance challenges associated with how AV algorithms are designed. For instance, AV programming may specify when an AV should violate traffic laws when doing so would be safer than complying (e.g., crossing a double line to avoid a road hazard). Different programmers may tell AVs to make different choices in such scenarios. Policymakers will need to determine whether and how standards for algorithm design should be established.

Finally, it is essential for policymakers to consider how to protect consumer privacy rights, particularly if data sharing becomes standard practice in the AV sector.

42 Anderson et al., "Rethinking Insurance and Liability in the Transformative Age of Autonomous Vehicles."
43 *Carpenter v. U.S.*, 585 U.S. _____ (2018), 17.

IV. POLICY RECOMMENDATIONS

Good governance is essential to facilitating market entry and ensuring responsible deployment of AVs. There is an immediate need to define federal, state, and local roles in AV governance, as the current regulatory landscape includes overlapping and/or unclear authorities. Once authorities are clarified, policymakers can adopt a "permissive but conscientious" approach to AV governance, encouraging creativity and experimentation while also being thoughtful about the ways in which AVs could impact society. This section provides a set of principles and suggests specific policy options for achieving successful AV deployment.

PRINCIPLE 1. Empower local and state governments while minimizing regulatory patchworks and treading lightly around use of preemption.

At the federal level, the USDOT's NHTSA is well-positioned to continue to ensure that consistent safety requirements are applied to new AVs. To prepare for the likely environmental, social, and economic impacts of the AV revolution, however, the USDOT must work closely with other agencies—including but not limited to the EPA, the Department of Energy, and the Department of Labor—in addition to ensuring internal coordination.

Strong federal leadership must be complemented by state and local tailoring of policies to specific jurisdictional needs. A robust set of AV-related policy processes is already ongoing at the sub-national level, including by the National Conference of State Legislatures, National League of Cities, National Geospatial-Intelligence Agency, and United States Conference of Mayors. Such processes are important for fostering creative approaches that, once proven successful in one region, can be expanded and/or adapted to other areas. Table 1 lists several specific policy options for balancing federal, state, and local roles in AV governance. Table 1 also includes several specific policy options for ensuring that regions and localities are adequately prepared for AVs.

Table 1. Empower local and state governments while minimizing regulatory patchworks and treading lightly around use of preemption.

Policy Options	Federal	State	Local
Establish clear divisions between federal and state authority on safety regulations, building on current guidance. Clarify how driver licensing at the state level interacts with federal treatment of the vehicle as the "driver" and therefore covered by federal standards.	✓	✓	
Include AVs in planning processes by including potential impacts from AVs in state, regional, and local long- and short-range plans. Consider how AVs might support and detract from goals related to the environment, equity, and other local priorities.		✓	✓
Establish insurance liability frameworks for AVs that can appropriately price risk and incentivize safety.		✓	
Fund AV research and pilot projects for local and regional governments. Prioritize research initiatives and pilot projects that collect and share data with key stakeholders.	✓	✓	
Make sure any preemption language is carefully thought through and developed with stakeholder buy-in. Data from pilot and testing projects should inform the use of preemption and regulation to avoid unintended consequences. It is essential to maintain the important role local governments play in the safe and effective long-term deployment and success of AVs.	✓	✓	

Form AV working groups and advisory boards to support AV policy processes. Membership should include representatives of communities and constituencies likely to be affected by policy decisions.	✓	✓	✓

PRINCIPLE 2. Prioritize continuous improvement in AV safety.

Ensuring safety is a core goal of all public entities with oversight over AVs. Some safety-focused groups are enthusiastic about the adoption of AVs, while others encourage caution until AVs are "safe." It is unclear what "safe" means in the context of AVs. Does it mean safer than human drivers? Twice as safe? A hundred times safer? Although it will be difficult or impossible for policymakers to identify a safety threshold that satisfies all parties, policymakers *can* ensure that AVs are only deployed when they are likely safer than human drivers and can take steps to ensure that AV safety continues to improve.

Policymakers and other stakeholders should also explore different avenues for assessing AV safety, including the use of simulations and technology testing. Humans must pass a driving test to obtain a driver's license. It is not unreasonable to consider applying a similar standard to ensure that AVs from different manufacturers comply with state and local laws. Policy options that governments can take to ensure these goals are met are outlined in Table 2. This set of actions does not include cybersecurity-specific policies, as they are out of the scope of this paper.

Table 2. Prioritize continuous improvement in AV safety.

Policy Options	Federal	State	Local
Update the FMVSS to incorporate HAVs. New standards should be performance-based rather than design-based to allow effective regulation of rapidly evolving AV technology. Tests that verify HAVs and associated technologies, including sensors and cameras, should be included to ensure minimum safety standards for HAVs.	✓		
Ensure that NHTSA continues to have recall authority over new technologies and software associated with AVs. Clarify cases that would result in use of defect authority. Establish protocols for AV software recalls in the event that a critical safety or security flaw takes place after an update.	✓		
Encourage continuous improvement in AV safety by creating penalties that scale with the degree to which the incident in question was avoidable based on known previous incidents.	✓	✓	
Require that AV developers obtain testing permits to operate on public roads. It may be necessary to initially restrict AV operation to specific geographic areas and road types. Restrictions could be eased or lifted as AV technology matures and AVs are integrated into transportation systems.	✓	✓	
Encourage collaboration on safety efforts. For instance, automakers could collaborate with the Insurance Institute for Highway Safety and the Information Sharing and Analysis Center to address potential safety risks and advance safety features.	✓	✓	✓

PRINCIPLE 3. Encourage AV data collection and sharing while protecting privacy

Data on AV driving behavior, travel routes, speed, and other elements of operation can support informed policymaking. Such data can also help increase public understanding of and confidence in AV technology.

However, collection and sharing of AV data must be balanced with privacy concerns. Local governments and other entities that seek to benefit from AV data may also lack the resources to securely host and analyze very large and rapidly growing datasets. Third-party frameworks, repositories, and services may be needed to distill key insights from AV data. Specific policy options designed to achieve these goals are listed in Table 3.

Table 3. Encourage AV data collection and sharing while protecting privacy

Policy Options	Federal	State	Local
Establish standards and processes for responsible AV data collection, sharing, and use. Standards may differ for private and commercial AVs but should generally establish processes governing regular data collection and addressing privacy and proprietary concerns. Regularly evaluate data needs for priority topics (e.g. related to testing accidents and failures, miles traveled, energy consumption, etc.).	✓	✓	✓
Require that AVs be equipped with monitoring devices that capture sensor data before and after collision occurrence.	✓		
Require AV automakers to clearly disclose what data they collect, how such data is used, and how privacy is protected.	✓	✓	
Create data warehouses that ensure interoperability and serve as central repositories for shared information related to testing collisions and failures. These warehouses could be established and managed by national labs, universities, or other quasi-public entities with strong technical capabilities.	✓	✓	
Create a publicly accessible incident database (for crashes, near-misses, and high-risk situations) and compel or incentivize AV automakers to contribute data. Incident data generally should not include information that may compromise the intellectual property of AV developers, such as how an AV may respond to a situation.	✓	✓	

V. CONCLUSION

AVs hold considerable promise to improve safety, system efficiency, environmental performance, and transportation economics. However, the current policy environment is not well suited for highly automated vehicle technologies. Improved AV governance is needed to encourage innovation while ensuring safety, achieve regulatory consistency across jurisdictional boundaries while giving states and localities flexibility to tailor policy to their own needs, and clarify questions related to regulatory authority, insurance, and liability. The result will be an advanced transportation system that works for all.

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