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Issues in Autonomous Vehicle Deployment

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Summary

Legislation recently passed by the House of Representatives—H.R. 3388—and pending in the Senate—S. 1885—would provide new regulatory tools to the National Highway Traffic Safety Administration (NHTSA) to oversee autonomous vehicles. Autonomous vehicles are seen as a way to reduce motor vehicle crashes; for example, there were 37,461 deaths from motor vehicle crashes in 2016 and nearly all of them were caused by driver error. However, despite unanimous approval in House and Senate committees and on the House floor, the legislation has proven controversial in the wake of several high-profile accidents involving autonomous vehicles being tested on public roads.

At present, no fully autonomous vehicles are available for public use. Many new vehicles have automated some driver functions, but all require a human to monitor the driving environment and control the vehicle. However, rapid advances in technology have made it likely that vehicles with high levels of automation will be on the market within a few years, raising questions about the adequacy of existing methods of safety oversight.

The federal government and the states share motor vehicle regulation, with the federal government responsible for vehicle safety and states for driver-related aspects such as licensing and registration. While NHTSA has the statutory authority to regulate all types of motor vehicles, its traditional standard-setting process would take many years at a time when vehicle innovation is changing rapidly; standards envisioned now could be obsolete by the time they took effect. In the absence of NHTSA regulation of autonomous vehicles, nearly half the states have enacted laws on different aspects of autonomous vehicle deployment, resulting in a wide variety of state regulation.

On September 6, 2017, the House of Representatives passed by voice vote H.R. 3388. The legislation, which incorporates some provisions recommended in 2016 and 2017 U.S. Department of Transportation (DOT) reports, would preempt state regulation of some aspects of autonomous vehicle deployment, while providing new regulatory tools to NHTSA. H.R. 3388 would

- preempt states from regulating the design of autonomous vehicles, unless those laws are identical to federal law;
- expand NHTSA's authority to grant exemptions from its standards to encourage innovation;
- require each manufacturer to submit a "safety assessment certification" showing how it is addressing autonomous vehicle safety;
- mandate within one year of enactment a NHTSA report indicating what federal safety standards must be updated and listing its vehicle safety priorities; and
- require manufacturers to publicize their cybersecurity and data privacy plans.

The legislation would also establish an advisory committee, a new regulation for rear-seat occupant alerts (to reduce infant fatalities), and a review of headlamp standards. On November 8, 2017, the Senate Committee on Commerce, Science, and Transportation reported S. 1885, legislation that is similar in many respects to the House-passed legislation. Both bills address state preemption, safety standards, exemption authority, consumer information, cybersecurity, and privacy, but differ in their details.

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Introduction

Autonomous vehicles, which would carry out many or all of their functions without the intervention of a driver, may bring sweeping social and economic changes in their wake. The elderly, disabled Americans, urban residents, and those who do not own a car may have new travel options. Travel on public roads and highways could become less congested. Highway travel could become safer as well: U.S. roadway fatalities rose in 2015 and 2016, the first annual increases in more than 50 years,[1] and a study by the National Highway Traffic Safety Administration (NHTSA) has shown that 94% of crashes are due to human errors,[2] which autonomous vehicles could reduce. As a U.S. Department of Transportation (DOT) report noted, highly automated vehicles "hold a learning advantage over humans. While a human driver may repeat the same mistakes as millions before them, a [highly automated vehicle] can benefit from the data and experience drawn from thousands of other vehicles on the road."[3]

Congressional committees have held numerous hearings on federal policy regarding automated vehicles, and have debated changes in federal regulation to encourage vehicular innovation while protecting passenger safety. In July 2017, the House Energy and Commerce Committee unanimously ordered to be reported the first major legislation on autonomous vehicles (H.R. 3388); the House of Representatives passed that legislation by voice vote on September 6, 2017. The Senate Committee on Commerce, Science, and Transportation reported S. 1885 on November 28, 2017. However, since the House vote and the Senate committee consideration, several accidents involving autonomous vehicles operating under test conditions have raised new questions about how federal and state governments should regulate vehicle testing and the introduction of new technologies into vehicles offered for sale.[4]

Technology of Autonomous Vehicles

The technologies used in autonomous vehicles are very different from the predominantly mechanical, driver-controlled technology of the 1960s, when the first federal vehicle safety laws were enacted. Increasingly, vehicles can be controlled through electronics with little human involvement. Performance can be altered via over-the-air software updates. A range of advanced driver assistance systems is being introduced to motor vehicles, many of them bringing automation to vehicular functions once performed only by the driver. These features automate lighting and braking, connect the car and driver to the Global Positioning System (GPS) and smartphones, and keep the vehicle in the correct lane. Three forces drive motor vehicle innovation

[1] In 2016, there were 37,461 people killed in crashes on U.S. roadways, a 5.6% increase over 2015; there were 35,485 motor vehicle fatalities in 2015, an 8.4% increase over 2014. These two years reverse over 50 years of declining fatalities on U.S. roadways. National Highway Traffic Safety Administration, *2016 Fatal Motor Vehicle Crashes: Overview*, DOT HS 812 456, October 2017, p. 1, https://www.nhtsa.gov/press-releases/usdot-releases-2016-fatal-traffic-crash-data.

[2] S. Singh, *Critical Reasons for Crashes Investigated in the National Motor Vehicle Crash Causation Survey*, National Highway Traffic Safety Administration, DOT HS 812 115, February 2015.

[3] U.S. Department of Transportation and National Highway Traffic Safety Administration, *Federal Automated Vehicles Policy: Accelerating the Next Revolution in Roadway Safety*, September 2016, p. 5, https://www.transportation.gov/AV/federal-automated-vehicles-policy-september-2016.

[4] For example, a pedestrian was killed by an autonomous vehicle operated by Uber on March 18, 2018, an incident that is being investigated by the National Transportation Safety Board (NTSB). See National Transportation Safety Board, "Car with automated vehicle controls crashes into pedestrian," press release, March 21, 2018, https://www.ntsb.gov/investigations/Pages/HWY18FH010.aspx.

- technological advances enabled by new materials and more powerful, compact electronics;
- consumer demand for telecommunications connectivity and new types of vehicle ownership and ridesharing; and
- regulatory mandates pertaining to emissions, fuel efficiency, and safety.

Increasingly, such innovations are being combined as manufacturers produce vehicles with higher levels of automation. Vehicles do not fall neatly into the categories of "automated" or "nonautomated," because all of today's motor vehicles have some element of automation.

The Society of Automotive Engineers International (SAE), an international standards-setting organization, has developed six categories of vehicle automation—ranging from a human driver doing everything to automated systems performing all the tasks once performed by a driver. This classification system (**Table 1**) has been adopted by DOT to foster standardized nomenclature to aid clarity and consistency in discussions about vehicle automation and safety.

Table 1. Levels of Vehicle Automation

SAE Automation Category	Vehicle Function
Level 0	Human driver does everything.
Level 1	An automated system in the vehicle can sometimes assist the human driver conduct some parts of driving.
Level 2	An automated system can conduct some parts of driving, while the human driver continues to monitor the driving environment and performs most of the driving.
Level 3	An automated system can conduct some of the driving and monitor the driving environment in some instances, but the human driver must be ready to take back control if necessary.
Level 4	An automated system conducts the driving and monitors the driving environment, without human interference, but this level operates only in certain environments and conditions.
Level 5	The automated system performs all driving tasks, under all conditions that a human driver could.

Source: DOT and NHTSA, *Federal Automated Vehicles Policy*, September 2016, p. 9, https://www.transportation.gov/AV/federal-automated-vehicles-policy-september-2016.

Note: SAE is the Society of Automotive Engineers International, http://www.sae.org.

Vehicles sold today are in levels 1 and 2 of SAE's automation rating system. Views differ as to how long it may take for full automation to become standard. Some forecast market-ready autonomous vehicles at levels 3 to 5 within five years.[5] Others argue that it will take much longer, as more testing, regulation, and policy work should be done before autonomous vehicles beyond level 2 are widely deployed.[6]

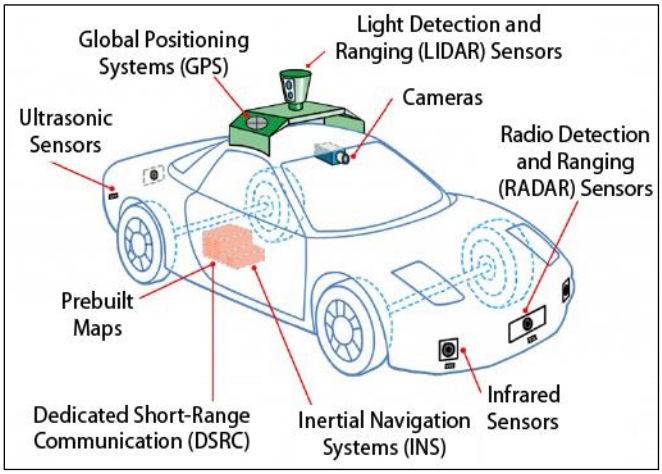
Technologies that could guide an automated vehicle (**Figure 1**) include a wide variety of electronic sensors that would determine the distance between the vehicle and obstacles; detect lane markings, pedestrians, and bicycles; park the vehicle; use GPS, inertial navigation, and a

[5] Dr. James Hedlund, *Autonomous Vehicles Meet Human Drivers: Traffic Safety Issues for States*, Governors Highway Safety Association, February 2, 2017, p. 5, http://www.ghsa.org/resources/spotlight-av17.

[6] Jeremy Gelbart, "You May Not Live Long Enough to Ride a Driverless Car," *Newsweek*, April 1, 2017, http://www.newsweek.com/you-may-not-live-long-enough-ride-driverless-car-575305.

system of built-in maps to guide the vehicle direction and location; employ cameras that provide 360-degree views around the vehicle; and use dedicated short-range communication (DSRC) to monitor road conditions, congestion, crashes, and possible rerouting. These technologies are being offered in various combinations on vehicles currently on the market, as manufacturers study how to combine them in vehicles that could safely transport passengers without drivers.

Figure 1. Autonomous Vehicle Technologies



Source: CRS, based on "Autonomous Vehicles" fact sheet, Center for Sustainable Systems, University of Michigan.

While private-sector development has focused on vehicle equipment, federal and academic researchers, along with industry, have spent over a decade developing complementary sensor technologies that could improve safety and vehicle performance. These include vehicle-to-vehicle (V2V) and vehicle-to-infrastructure (V2I) capabilities—often referred to with the composite term V2X.

V2X technology relies on communication of information to warn drivers about dangerous situations that could lead to a crash, using dedicated short-range communication to exchange messages about vehicles' speeds, braking status, stopped vehicles ahead, or blind spots to warn drivers so they can take evasive action. V2X messages have a range of 300 meters (a fifth of a mile)—up to twice the distance of onboard sensors—cameras, and radar.[7] These radio messages can "see" around corners and through other vehicles.

NHTSA has evaluated V2X applications and estimates that just two of them could reduce the number of crashes by 50%: intersection movement assist warns the driver when it is not safe to enter an intersection, and left turn assist warns a driver when there is a strong probability of colliding with an oncoming vehicle when making a left turn. V2V communications may also permit technologies such as forward collision warning, blind spot warning, and do-not-pass warnings. NHTSA estimated in 2014 that installing V2V communications capability will cost about $350 per vehicle.[8]

[7] National Highway Traffic Safety Administration, *Vehicle-to-Vehicle Communication Technology*, p. 1, https://www.nhtsa.gov/technology-innovation/vehicle-vehicle-communications.

[8] Ibid., p. 3.

Federal Regulatory Issues

DOT has issued two reports on federal regulatory issues with regard to autonomous vehicles, based on consultations with industry, technology and mobility experts, state governments, safety advocates, and others. DOT anticipates that it will continue to issue annual updates on federal regulatory guidance, in light of the pace of autonomous vehicle innovation.

The first report issued by DOT, *Federal Automated Vehicles Policy*,[9] laid the foundation for regulation and legislation by clarifying DOT's thinking in four areas

- a set of *guidelines* outlining best practices for autonomous vehicle design, testing, and deployment;
- a *model state policy* that identifies where new autonomous vehicle-related issues fit in the current federal and state regulatory structures;
- a *streamlined review process* to expedite requests for DOT regulatory interpretations to spur autonomous development; and
- identification of *new tools and regulatory structures* for NHTSA that could aid in autonomous deployment, such as expanded exemption authority and premarket testing to assure that autonomous vehicles will be safe.

Guidelines

The 2016 guidelines identified 15 practices and procedures that DOT expected manufacturers, suppliers, and service providers—such as Uber and Lyft ridesourcing companies—to follow in testing autonomous vehicles.[10] It was expected that the data generated from this research would be widely shared with government and the public while still respecting competitive interests.

Manufacturers, researchers, and service providers were urged to ensure that their test vehicles meet applicable NHTSA safety standards[11] and that their vehicles be tested through simulation, on test tracks, or on actual roadways. To assist in the regulatory oversight, NHTSA requested each entity testing autonomous vehicles to submit Safety Assessment letters that will outline how it is meeting the guidelines, addressing such issues as data recording, privacy, system safety, cybersecurity, and crashworthiness. DOT specified that vehicle software must be capable of being updated through over-the-air means (similar to how smartphones are currently updated), so improvements can be diffused quickly to vehicle owners.[12]

Model State Policy

Any vehicle operating on public roads is subject to dual regulation by the federal government and the states in which it is registered and driven. Traditionally, NHTSA has regulated auto safety,

[9] U.S. Department of Transportation and National Highway Traffic Safety Administration, *Federal Automated Vehicles Policy: Accelerating the Next Revolution in Roadway Safety*, September 2016, https://www.transportation.gov/AV/federal-automated-vehicles-policy-september-2016.

[10] The 15 practices and procedures: data recording and sharing; privacy; system safety; vehicle cybersecurity; human machine interface; crashworthiness; consumer education and training; registration and certification; postcrash behavior; federal, state, and local laws; ethical considerations; operational design domain; object and event detection and response; fall back; and validation methods. Ibid., p. 15.

[11] Federal Motor Vehicle Safety Standards (FMVSS).

[12] *Federal Automated Vehicles Policy*, pp. 11-36.

while states have licensed automobile drivers, established traffic regulations, and regulated automobile insurance.[13] DOT's 2016 report clarified and restated that division of responsibilities for the transition to fully autonomous vehicles with the automobile itself being the driver.

The model state policy, developed by NHTSA in concert with the American Association of Motor Vehicle Administrators and other safety advocates, suggested state roles and procedures,[14] including administrative issues (designating a lead state agency for autonomous vehicle testing), an application process for manufacturers that want to test vehicles on state roads, coordination with local law enforcement agencies, changes to vehicle registration and titling, and liability and insurance. Liability may change significantly with autonomous vehicles, as states will have to reconsider the extent to which vehicle owners, operators, passengers, vehicle manufacturers, and component suppliers bear responsibility for accidents when no one is actively driving the vehicle.

Current Federal Regulatory Tools

In addition to its existing authority to issue federal vehicle safety standards and order recalls of defective vehicles, NHTSA has other tools it can use to address the introduction of new technologies: letters of interpretation, exemptions from current standards, and rulemakings to issue new standards or amend existing standards.

NHTSA uses letters of interpretation when it receives requests seeking clarifications of existing law. It may take NHTSA several months or even years to issue a letter of interpretation, which cannot make substantive changes to regulations.

The agency can grant exemptions from safety standards in certain circumstances. They are not granted indefinitely—an exemption may last for two or three years—or for a large number of vehicles.[15] The approval process may take months or years. Rulemaking to adopt new standards or modify existing ones generally takes several years and requires extensive public comment periods.

Proposed New Regulatory Tools

Federal Automated Vehicles Policy identified potential new tools and authorities that could affect the way autonomous vehicles are regulated. These included the following:

- Premarket safety assurance tools such as premarket testing, data, and analyses reported by a manufacturer to demonstrate that a new vehicle met standards before being deployed on public roads. The report asserted that some of these tools could be used without new statutory authority.
- Premarket approval authority,[16] as distinct from safety assurance as well as from the self-certification process used for the past 50 years.[17] The report indicated this could be used to replace self-certification for autonomous vehicles, requiring

[13] State responsibilities include driver and vehicle licensing, enforcement of traffic laws, vehicle safety inspections, and regulating motor vehicle insurance and liability. Ibid., p. 38.

[14] Ibid., p. 37.

[15] In most cases, NHTSA can consider an exemption for up to 2,500 vehicles per year. Ibid., p. 56.

[16] Other federal agencies use this process now. For example, the Federal Aviation Administration uses it to regulate software such as autopilot programs used on commercial aircraft. Ibid., p. 71.

[17] Automakers self-certify that their vehicles meet all federal motor vehicle safety standards. NHTSA does not test new models before they come on the road, but later spot tests to ensure that new vehicles are in compliance.

NHTSA to test prototype vehicles to ensure that they met all federal motor vehicle safety standards. It said NHTSA would need new statutory authority and additional resources to take on certification procedures now handled by manufacturers.

- Imminent hazard authority to permit NHTSA to take immediate action to curtail serious safety risks that could harm the public. The Obama Administration unsuccessfully argued that this new tool be included in the 2015 surface transportation bill.[18]
- Expanded exemption authority for autonomous vehicles. The report recommended raising the current limit of 2,500 vehicles that can be exempted from federal safety standards in order to provide a larger database of real-world experience for analyzing on-road safety readiness of exempted vehicles. The report described several alternative ways in which an expanded exemption could operate, and noted that "it would be important to guard against overuse of the authority such that exemptions might displace rulemaking as the de facto primary method of regulating motor vehicles and equipment."[19]
- Enhanced data collection tools allowing NHTSA to utilize the large amounts of data collected by autonomous vehicles. One example would be to employ event data recorders—now used in a limited way on nearly all motor vehicles to record vehicle and driver information in the seconds before a crash—for use in autonomous vehicles to identify safety-related defects. NHTSA said it has the statutory authority now for this tool.

Trump Administration Revises DOT Guidelines

The Trump Administration issued changes to *Federal Automated Vehicles Policy* on September 12, 2017, announcing at the same time that DOT plans to issue annual automated driving systems (ADS) policy updates in light of the pace of vehicle innovation. The latest voluntary guidance, *Automated Driving Systems 2.0: A Vision for Safety*,[20] clarifies for manufacturers, service providers, and states some of the issues raised in the Obama Administration's predecessor report and replaces some parts of the earlier guidance; the new policy recommendations took effect immediately.[21] In developing the revised autonomous vehicle policy, DOT evaluated comments, public meeting proceedings, recent congressional hearings, and state activities. Among the clarifications, which affect Level 3 through 5 vehicles, are the following:

Whereas the 2016 DOT report listed 15 *vehicle performance guidelines* for testing practices and procedures, the 2017 DOT report cites 12, eliminating recommendations concerning privacy; registration and certification; and ethical considerations. A DOT web page notes that "elements involving privacy, ethical considerations, registration, and the sharing of data beyond crash data remain important and are areas for further discussion and research."[22]

[18] Fixing America's Surface Transportation (FAST) Act, P.L. 114-94.

[19] *Federal Automated Vehicles Policy*, p. 76.

[20] DOT and NHTSA, *Automated Driving Systems 2.0: A Vision for Safety*, DOT HS 812 442, September 2017, https://www.nhtsa.gov/sites/nhtsa.dot.gov/files/documents/13069a-ads2.0_090617_v9a_tag.pdf.

[21] Ibid., p. 1.

[22] https://www.nhtsa.gov/manufacturers/automated-vehicles-manufacturers.

These vehicle performance guidelines, and the manufacturers' compliance with them, which had to be reported to NHTSA in mandatory Safety Assessment letters under the 2016 policy, have now been made voluntary and no reports are required. Instead, organizations testing autonomous vehicles are encouraged to address the 12 procedures and processes by publishing voluntary self-assessments of how their testing procedures align with NHTSA's recommended procedures, and sharing them with consumers, governments, and the public so a better understanding of autonomous vehicle capabilities is developed.[23]

The 2016 policy indicated that in the future NHTSA might make these guidelines mandatory through rulemaking. That language has been replaced with a statement that "assessments are not subject to federal approval."[24]

The 2017 report provides best practices recommended for state legislatures with regard to Level 3 and 4 vehicles, building on DOT's Model State Policy issued in 2016. DOT notes that it is not necessary that all state laws with regard to autonomous vehicles be uniform, but rather that they "promote innovation and the swift, widespread, safe integration of ADSs."[25] In the 2017 report, NHTSA recommends states adopt four safety-related types of legislation covering the following:

- A technology-neutral environment. Legislation proposed in some states would grant motor vehicle manufacturers special standing over other organizations in testing autonomous vehicles, but the 2017 report states that "no data suggests that experience in vehicle manufacturing is an indicator of the ability to safely test or deploy vehicle technology,"[26] and DOT counsels that all organizations meeting federal and state "law prerequisites" should be able to test vehicles.
- Licensing and registration procedures.
- Reporting and communications methods for public safety officials.
- Review of traffic laws and regulations that could be barriers to ADS testing and deployment.

Automated Driving Systems 2.0: A Vision for Safety also includes best practices for state highway safety officials, including registration and titling and liability and insurance.[27]

State Concerns

According to the National Conference of State Legislatures, 22 states plus the District of Columbia have enacted legislation related to autonomous vehicles (**Figure 2**); related bills were introduced in 33 states in 2017; and governors in 10 states have issued executive orders dealing with autonomous vehicles. DOT's model state policy and H.R. 3388, as passed by the House of Representatives, reflect concerns that the absence of federal regulation covering autonomous vehicles may encourage states to move forward on their own, potentially resulting in diverse and even conflicting state regulations.

[23] NHTSA will feature a template on its website, illustrative of the type of information an organization might provide, *Automated Driving Systems 2.0: A Vision for Safety*, p. 16.

[24] *Automated Driving Systems 2.0: A Vision for Safety*, p. 16.

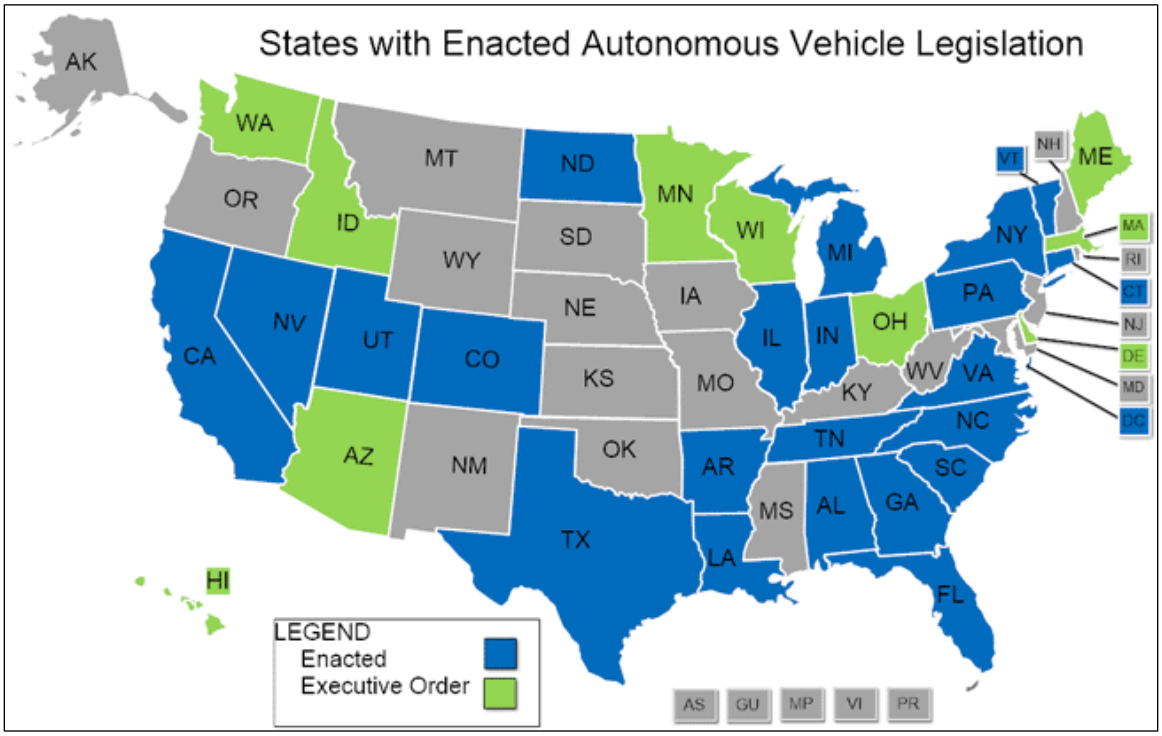
[25] *Automated Driving Systems 2.0: A Vision for Safety*, p. 20.

[26] Ibid., p. 21.

[27] Ibid., pp. 22-24.

State laws with regard to autonomous vehicles vary widely. Florida was the first state to permit anyone with a valid driver's license to operate an autonomous vehicle on public roads, and it does not require an operator to be in the vehicle. In California, the regional Contra Costa Transportation Authority approved the testing on certain public roads of autonomous vehicles not equipped with a steering wheel, brake pedal, or accelerator. A Tennessee law bars local governments from prohibiting the use of autonomous vehicles. North Dakota and Utah enacted laws to study safety standards and report back to the legislature with recommendations. Michigan enacted several bills in 2016 that permit autonomous vehicles to be driven on public roads, address testing procedures, and establish the American Center for Mobility for testing vehicles.[28]

Figure 2. States with Enacted Autonomous Vehicle Measures



Source: National Conference of State Legislatures, viewed on May 10, 2018, http://www.ncsl.org/research/transportation/autonomous-vehicles-self-driving-vehicles-enacted-legislation.aspx.

Note: States in gray have not issued executive orders or enacted legislation on autonomous vehicles.

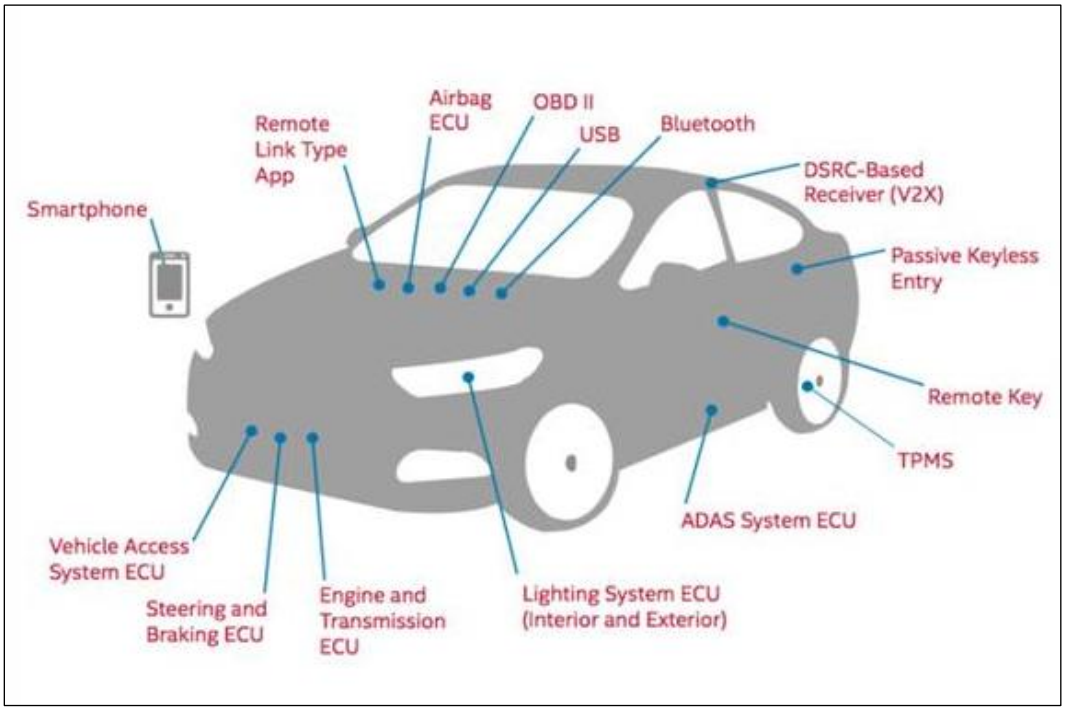
Cybersecurity and Data Privacy

The more automated vehicles become, the more sensors and computer components are employed to provide functions now handled by the driver. Many of these new automated components will generate large amounts of data about the vehicle, its location at precise moments in time, driver behavior, and vehicle performance, thereby opening new portals for possible unauthorized access to vehicle systems and the data generated by them.

[28] Ben Husch and Anne Teigen, "Regulating Autonomous Vehicles," National Conference of State Legislatures, LegisBrief, Vol. 15, No. 13, April 2017, http://www.ncsl.org/documents/legisbriefs/2017/lb_2513.pdf.

Protecting autonomous vehicles from hackers is of paramount concern to federal and state governments, manufacturers, and service providers. A well-publicized hacking of a conventional vehicle by professionals[29] demonstrated to the public that such disruptions can occur. Hackers could use more than a dozen portals to enter even a conventional vehicle's electronic systems (**Figure 3**), including seemingly innocuous entry points such as the airbag, lighting systems, and tire pressure monitoring system (TPMS).[30] Requirements that automated vehicles accept remote software updates, so that owners do not need to take action each time software is revised, are in part a response to concerns that security weaknesses be rectified as quickly as possible.

Figure 3. Entry Points for Vehicle Hacking



Source: Tom Huddleston Jr., "This graphic shows all the ways your car can be hacked," *Fortune*, September 15, 2015, http://fortune.com/2015/09/15/intel-car-hacking/.

Note: Graphic courtesy of Intel Corp.

To address these concerns, motor vehicle manufacturers established the Automotive Information Sharing and Analysis Center (Auto-ISAC),[31] which released a set of cybersecurity principles in 2016. DOT's automated vehicle policies address cybersecurity, calling for a product development process that engineers into vehicle electronics a thorough cybersecurity threat mitigation system, and sharing of incidents, threats, and violations to the Auto-ISAC so that the broader vehicle industry can learn from them.

Aside from hackers, many legitimate entities would like to access vehicle data, including the manufacturer, the supplier providing the technology and sensors, the vehicle owner and

[29] Hackers showed that they could remotely disable a Jeep's engine and brakes; Fiat Chrysler later addressed the vulnerability. Andy Greenberg, "Hackers Remotely Kill a Jeep on the Highway—With Me in It," *Wired*, July 21, 2015, https://www.wired.com/2015/07/hackers-remotely-kill-jeep-highway/.

[30] TPMS is an electronic system designed to monitor the air pressure inside pneumatic tires.

[31] https://www.automotiveisac.com.

occupants, urban planners, insurance companies, law enforcement, and first responders (in case of an accident). Relevant types of data include the following:

Vehicle testing crash data. DOT's autonomous vehicle policy reports address how data from vehicle crashes during a test should be handled, with entities conducting the testing adopting best practices established by standard-setting organizations such as the Institute of Electrical and Electronics Engineers (IEEE) and SAE. NHTSA recommended that the data from autonomous vehicle crashes be stored and made available for retrieval and shared with the government for crash reconstruction.[32]

Data Ownership. Current law does not address ownership of most of the data collected by vehicle software and computers. Most new conventional vehicles on the road have an event data recorder (EDR), which captures a limited amount of information about a vehicle, the driver, and passengers in the few seconds before a crash (e.g., speed and use of seat belts). The most recent surface transportation legislation[33] enacted the Driver Privacy Act of 2015 to address data ownership with regard to EDRs—establishing that EDR data is property of the vehicle owner—but it does not govern the other types of data that will be accumulated by autonomous vehicles. The National Association of City Transportation Officials has recommended that the federal government identify these data, their ownership, and instances where they should be shared.[34]

Consumer Privacy. The 2016 DOT report included a section on privacy, but the 2017 DOT report omits that discussion. In the earlier report, DOT discussed elements that testing organizations' policies should include, such as transparency for consumers and owner access to data.[35] Separately, two motor vehicle trade associations have developed *Privacy Principles for Vehicle Technologies and Services*, which are similar to the practices discussed in the 2016 DOT report.[36]

Educating Motorists and Pedestrians

There may not be a consensus on when large numbers of autonomous vehicles will hit U.S. roads, but whenever that time comes, those vehicles will be a small segment of the more than 264 million passenger cars and light trucks now registered in the United States.[37] With Americans keeping their cars for an average of more than 11 years, traditional vehicles are likely to have a highway presence for decades.

Several recent studies and surveys reveal public skepticism about autonomous vehicles. A recent survey by IHS Markit, a market research firm, shows that motorists overwhelmingly approve of some Levels 1 and 2 automated vehicle technologies—such as blind spot detection and automatic emergency braking—but that fully autonomous vehicles are not as popular.[38] A similar 2017

[32] *Automated Driving Systems 2.0: A Vision for Safety*, p. 14.

[33] Fixing America's Surface Transportation (FAST) Act.

[34] Paul Lewis, Gregory Rogers, and Stanford Turner, *Beyond Speculation: Automated Vehicles and Public Policy*, Eno Center For Transportation, May 2, 2017, https://www.enotrans.org/etl-material/beyond-speculation-automated-vehicles-public-policy/.

[35] *Federal Automated Vehicles Policy*, p. 19.

[36] Alliance of Automobile Manufacturers and the Association of Global Automakers, https://autoalliance.org/connected-cars/automotive-privacy-2/principles/.

[37] Jack Walsworth, "Average age of vehicles on road hits 11.6 years," *Automotive News*, November 22, 2016, http://www.autonews.com/article/20161122/RETAIL05/161129973/average-age-of-vehicles-on-road-hits-11.6-years.

[38] IHS Markit, "Survey Finds Varied Autonomy and Safety Technology Preferences for New Vehicles, IHS Markit

study by J.D. Power, a consumer research firm, found that most Americans are becoming more skeptical of self-driving motor vehicle technology, although strong interest exists in some of the elements of autonomy, such as collision protection and driving assistance technologies. The report noted that "automated driving is a new and complex concept for many consumers; they'll have to experience it firsthand to fully understand it."[39] The Governors Highway Safety Association also reported on three additional surveys with similar results.[40]

To address the lack of understanding about autonomous vehicles, the 2017 DOT report calls for major consumer education and training as vehicles are tested and deployed. Organizations testing vehicles are encouraged to "develop, document, and maintain employee dealer, distributor, and consumer education and training programs to address the anticipated differences in the use and operation of ADSs from those of the conventional vehicles that the public owns and operates today."[41]

DOT underscores the need for a wide range of potential autonomous-vehicle users to become familiar before vehicles are sold to consumers, using on- and off-road demonstrations, virtual reality, and onboard vehicle systems. Others have made suggestions for consumer education about autonomous vehicles, including the following:

- the vehicle should let people on the road—including pedestrians—know when a vehicle is in self-driving mode;
- vehicle sales representatives should be trained about the technical aspects of the vehicle and the benefits and risks of such vehicles compared to conventional vehicles; and
- manufacturers should hold training seminars, including crashworthiness and fall back options (should a system fail), with updates as new levels of autonomy are introduced.[42]

Congressional Action

Committees in the House of Representatives and the Senate have held numerous hearings on the technology of autonomous vehicles and possible federal issues that could result from their deployment. On September 6, 2017, the House of Representatives passed by voice vote H.R. 3388, the SELF DRIVE Act.[43] A different Senate bill, S. 1885, the AV START Act,[44] was reported by the Committee on Commerce, Science, and Transportation on November 28, 2017. Prior to the

Says," press release, August 3, 2017, http://news.ihsmarkit.com/press-release/automotive/survey-finds-varied-autonomy-and-safety-technology-preferences-new-vehicles.

[39] Over the three years it has been surveying on this topic, J.D. Power reported in *U.S. Tech Choice Study* that all U.S. generational groups except Gen Y (individuals born between 1977 and 1994) are showing less acceptance of autonomous vehicles. J.D. Power, "Hands Off? Not Quite. Consumers Fear Technology Failures with Autonomous Vehicles," press release, April 18, 2017, http://www.jdpower.com/press-releases/jd-power-2017-us-tech-choice-study.

[40] *Autonomous Vehicles Meet Human Drivers: Traffic Safety Issues for State*, p. 6.

[41] *Automated Driving Systems 2.0: A Vision for Safety*, p. 15.

[42] Charles Mollenberg Jr., "Managing Consumer Expectations for Autonomous Vehicles," *Law 360*, August 28, 2017.

[43] Safely Ensuring Lives Future Deployment and Research In Vehicle Evolution Act.

[44] American Vision for Safer Transportation through Advancement of Revolutionary Technologies Act.

committee markup, the chairman and ranking member issued a set of principles they view as central to new legislation[45]

- *prioritize safety*, acknowledging that federal standards will eventually be as important for self-driving vehicles as they are for conventional vehicles;
- *promote innovation* and address the incompatibility of old regulations written before the advent of self-driving vehicles;
- *remain technology-neutral*, not favoring one business model over another;
- *reinforce separate but complementary federal and state regulatory roles*;
- *strengthen cybersecurity* so that manufacturers address potential vulnerabilities before occupant safety is compromised; and
- *educate the public* through government and industry efforts so that the differences between conventional and self-driving vehicles are understood.

The House and Senate bills address concerns about state action replacing some federal regulation, while also empowering NHTSA to take unique regulatory actions to ensure safety and encouraging innovation in autonomous vehicles. They retain and seek to clarify the current arrangement of states controlling most driver-related functions and the federal government being responsible for vehicle safety. The major provisions of the House and Senate bills focus on the following:

State Preemption. In H.R. 3388, states would not be allowed to regulate the design, construction, or performance of highly automated vehicles, automated driving systems, or their components unless those laws are identical to federal law.[46] The House-passed bill reiterates that vehicle registration, driver licensing, driving education, insurance, law enforcement, and crash investigations should remain in state jurisdiction as long as they do not restrict autonomous-vehicle development. H.R. 3388 provides that nothing in the preemption section should prohibit states from enforcing their laws and regulations on the sale and repair of motor vehicles.

S. 1885 would also preempt states from adopting laws, regulations, and standards that would regulate many aspects of autonomous vehicles, but would omit some of the specific powers reserved to the states under the House-passed bill. States would be prohibited from issuing drivers licenses for autonomous-vehicle operations that discriminate based on a disability. The bill provides that state preemption would end when NHTSA establishes standards covering these vehicles.

New Safety Standards. Within two years of enactment, H.R. 3388 would require DOT to issue a final rule requiring each manufacturer to show how it is addressing safety in its autonomous vehicles, with updates every five years thereafter. DOT would not be allowed to condition vehicle deployment on review of these self-assessments, however.[47] The regulation establishing the assessments would have to specify the 12 testing requirements and data necessary to demonstrate

[45] Bipartisan Principles for Self-Driving Vehicles were announced by Senators John Thune, Bill Nelson, and Gary Peters on June 13, 2017. Senator Gary Peters, "Senators Release Bipartisan Principles for Self-Driving Vehicles Legislation," press release, June 13, 2017.

[46] The bill would permit states and the federal government to prescribe higher standards for autonomous vehicles they purchase for their own use.

[47] Self-assessments would address a dozen issues such as human machine interface, cybersecurity, and crashworthiness.

safety in the operation of the autonomous vehicle. In the interim, manufacturers would have to submit safety assessment letters.[48]

S. 1885 would not require a new NHTSA rule. Instead, it would require manufacturers and other vehicle developers to submit within 90 days of enactment a Safety Evaluation Report (SER) that would describe how they are addressing safety in nine issue areas. As in the House bill, vehicle deployment could not be conditioned on DOT review.

Safety Priority Plan. The House-passed bill would require DOT to submit a safety priority plan rulemaking within a year of enactment, indicating which existing federal safety standards must be updated to accommodate autonomous vehicles, the need for new standards, and NHTSA's safety priorities for autonomous vehicles and other vehicles.[49]

S. 1885 would put in place a somewhat different system, basing action on a report that DOT's Volpe Center would submit within 180 days of enactment.[50] NHTSA would be required to begin a rulemaking based on the report's recommendations and finalize it within a year.

Cybersecurity. Highly autonomous vehicles will rely on computers, sensors, and cameras to navigate, so cybersecurity protections will be necessary to ensure vehicle performance. The House-passed bill provides that no highly autonomous vehicle or vehicle with partial driving automation could be sold domestically unless a cybersecurity plan has been developed by the automaker. Such plans would have to be developed within six months of enactment and would include

- a written policy on mitigation of cyberattacks, unauthorized intrusions, and malicious vehicle control commands;
- a point of contact at the automaker with cybersecurity responsibilities;
- a process for limiting access to automated driving systems; and
- the manufacturer's plans for employee training and for maintenance of the policies.

The Senate Commerce, Science, and Transportation Committee bill would require written cybersecurity plans to be issued within 18 months of enactment, including a process for identifying and protecting vehicle control systems, detection, and response to cybersecurity incidents, and methods for exchanging cybersecurity information. A cybersecurity point of contact at the manufacturer or vehicle developer would have to be named. Unlike the House-passed bill, S. 1885 would direct DOT to create incentives so that vehicle developers would share information about vulnerabilities, and would specify that all federal research on cybersecurity risks should be coordinated with DOT.

In addition, S. 1885 would establish a Highly Automated Vehicle Data Access Advisory Committee to provide Congress with recommendations on cybersecurity issues. Federal agencies would be prohibited from issuing regulations pertaining to the access or ownership of data stored in automated vehicles until the advisory committee's report is submitted.

[48] The concept of safety assessment letters was identified as an interim tool in DOT's 2016 *Federal Automated Vehicles Policy*.

[49] New standards might include human machine interface, sensors, software, and cybersecurity.

[50] The John A. Volpe National Transportation Systems Center is a Massachusetts-based center of transportation and logistics expertise, operating under DOT, https://www.volpe.dot.gov; the Volpe Center report would identify potential conflicts between autonomous vehicles and existing Federal Motor Vehicle Safety Standards.

Exemption Authority. As recommended in DOT's 2016 *Federal Automated Vehicles Policy*, H.R. 3388 would expand DOT's ability to issue exemptions from existing safety standards to encourage autonomous-vehicle testing.[51] To qualify for an autonomous-vehicle exemption, a manufacturer would have to show that the safety level of the vehicle equals or exceeds the safety level of that standard for which an exemption is sought.

Whereas current laws limit exemptions to 2,500 vehicles per manufacturer per year, the House-passed bill would phase in increases over four years of up 100,000 vehicles per manufacturer per year.[52] The legislation provides constraints on the issuance of exemptions from crashworthiness and occupant protections standards. DOT would be directed to establish a publicly available and searchable database of motor vehicles that have been granted an exemption. Crashes of exempted vehicles would have to be reported to DOT.

S. 1885 would establish a process administered by NHTSA for reviewing autonomous-vehicle exemption requests, and applicants would have to verify that the safety level of their vehicle is equal to that of nonexempt vehicles. It would establish a slightly different phase-in of caps on the number of exemptions that could be issued in the four years after enactment.[53] The Senate Commerce, Science, and Transportation Committee bill does not address exemptions for crashworthiness and occupant protection standards. The establishment of a database of exempted vehicles is not required; reporting of exempt vehicle crashes would not be required.

Privacy. Before selling highly automated vehicles, the House-passed bill would require manufacturers to develop written privacy plans concerning the collection and storage of data generated by the vehicles, as well as a method of conveying that information to vehicle owners and occupants. However, a manufacturer would be allowed to exclude processes from its privacy policy that encrypt or make anonymous the sources of data. The Federal Trade Commission would be tasked with developing a report for Congress on a number of vehicle privacy issues.

Although S. 1885 would not explicitly require privacy plans by developers and manufacturers, it would require NHTSA to establish an online, searchable motor vehicle privacy database that would include a description of the types of information, including personally identifiable information (PII), that are collected about individuals during operation of a motor vehicle. This database would cover all types of vehicles—not just autonomous vehicles—and would include the privacy policies of manufacturers. The database would also include an explanation about how PII would be collected, retained, and destroyed when no longer relevant.

Consumer and Infrastructure Information. In H.R. 3388, DOT would be directed to complete a research program within three years that would lay the groundwork for a consumer-education program about the capabilities and limitations of highly automated vehicles. DOT would be mandated to issue a regulation requiring manufacturers to explain the new systems to consumers.

[51] For example, Federal Motor Vehicle Safety Standard 111 governs the performance and location of the rearview mirror. Fully autonomous vehicles would not need to be equipped with such mirrors because they rely on rear-facing sensors.

[52] In H.R. 3388, up to 25,000 vehicles could be exempted per manufacturer in the first year after enactment, then 50,000 in the second year and 100,000 in each of years three and four. DOT would not be permitted to raise the cap above 100,000 vehicle exemptions.

[53] S. 1885 would permit 15,000 exemptions per manufacturer in the first year after enactment, then 40,000 in the second year and 80,000 in years three and four. A manufacturer could request that DOT increase its exemption cap above 80,000. In evaluating the request for an increase in or a renewal of an exemption, DOT would be required to conduct a safety assessment of the original exemption.

The Senate Commerce, Science, and Transportation Committee bill would require NHTSA to develop a new regulation within three years that would provide information on autonomous vehicle capabilities and limitations at the point of sale of a vehicle.

S. 1885 would establish a two-year working group comprising industry and consumer groups that would identify marketing strategies and educational outreach to consumers, including information about the comparative safety of autonomous vehicles and nonautonomous vehicles. The working group would submit a report to Congress on its findings; there is no requirement that DOT initiate a rulemaking to implement the report's recommendations.

In addition, S. 1885 would require DOT to convene a separate panel of transportation and environmental experts who would be required to submit a report about the impact of autonomous vehicles on transportation infrastructure, mobility, the environment, and fuel consumption.

Highly Automated Vehicle Advisory Panels. H.R. 3388 would establish a new NHTSA advisory group with up to 30 members from business, academia, states and localities, and labor, environmental, and consumer groups to advise on mobility access for senior citizens and the disabled; cybersecurity; labor, employment, environmental, and privacy issues; and testing and information sharing among manufacturers. The council would end six years after enactment.

S. 1885 would establish a Highly Automated Vehicles Technical Committee to advise DOT on rulemaking policy and vehicle safety. The 15 committee members would be selected from SAE, vehicle manufacturers, safety organizations, and state and local governments based on their technical knowledge of automated driving systems. The committee would function for five years.

Manufacturing Study. The Senate Commerce, Science, and Transportation Committee bill would require DOT to study ways in which autonomous vehicles and parts can be produced domestically, with recommendations on how to incentivize such manufacturing. H.R. 3388 does not address this issue.

The House and Senate bills also address several vehicle safety standards not directly related to autonomous vehicles:

Rear Seat Occupant Alert System. In an effort to reduce or eliminate infant fatalities, H.R. 3388 and S. 1885 would direct DOT to issue a final regulation within two years requiring all new passenger vehicles to be equipped with an alarm system to alert the driver to check the back seats after the vehicle's motor or engine is shut off.

Headlamps. In the House-passed bill, DOT would be directed to initiate research into updating motor vehicle safety standards to improve performance and safety, and to revise the standards if appropriate. If NHTSA chooses not to revise the standards, it must report to Congress on its reasoning. S. 1885 does not address this issue.

Controversy with the Legislation

Since the Senate Commerce, Science, and Transportation Committee reported S. 1885 last year, several highly publicized crashes involving vehicles operating autonomously for testing purposes have prompted new concerns about how the federal government should regulate the new technologies. On March 18, 2018, a pedestrian was killed in Tempe, AZ, as she sought to cross the street: an Uber vehicle using automated control systems with a backup driver failed to detect her presence. Five days later, a driver of Tesla Model X with automated controls was killed when his vehicle hit a road barrier in Mountain View, CA. A Tesla Model S, which was reportedly using automated controls, was involved in a nonfatal crash with a stationary fire truck in Utah on May

11, 2018. The NTSB is investigating these accidents, as it did with a 2016 fatality in Florida involving a Tesla vehicle operating with automated controls.

Although H.R. 3388 passed the House of Representatives without objection and its Senate counterpart, S. 1885, was ordered reported by voice vote of the Commerce, Science, and Transportation Committee, these subsequent developments have delayed further action. Five Senators, including three members of the Senate Commerce, Science, and Transportation Committee, wrote to Senator John Thune, the committee's chairman, in March 2018 seeking changes to provisions governing state preemption, vehicle safety issues, cybersecurity, consumer privacy, and regulation of partially automated vehicles.[54]

Preemption of State and Local Laws

As there are currently few federal standards for autonomous vehicles, some states have begun enacting their own rules. This represents a departure from the traditional arrangement leaving regulation of vehicles to the federal government and authority over driver-related matters to the states. Both bills seek to identify a new regulatory arrangement by preempting new state and local safety standards for autonomous vehicles, but state and local governments have sought a role in federal advisory committees, notification of proposed exemptions from Federal Motor Vehicle Safety Standards, and clarification that traditional state and local authority over matters such as enforcing traffic laws will not be infringed.[55]

Vehicle Safety

Both H.R. 3388 and S. 1885 would allow large increases in the number of vehicles that could be exempted from NHTSA's Federal Motor Vehicle Safety Standards. The bills do not specify time limits on such exemptions and do not require that NHTSA review them after issuance, raising concerns that pedestrians and passengers in autonomous vehicles may not have the same level of protection as they do in conventional vehicles, current crashworthiness standards may be suspended for autonomous vehicles, and too many exempt vehicles will be allowed on the roads.[56]

Cybersecurity and Consumer Privacy

Although both pending bills contain cybersecurity provisions, these call for manufacturers to address cybersecurity without specific federal involvement. Some groups have called for the law to direct NHTSA to establish cybersecurity standards for all autonomous vehicles in Levels 2 through 5, as well as standards to require that backup drivers in test vehicles are fully engaged and not distracted.[57] Another proposal would require NHTSA to establish a publicly available

[54] Letter from Senator Dianne Feinstein, Senator Kirsten Gillibrand, Senator Edward Markey, Senator Richard Blumenthal, and Senator Tom Udall to Senators John Thune and Gary Peters, March 14, 2018, https://www.feinstein.senate.gov/public/index.cfm/press-releases?ID=46E4DC09-C5AB-4301-98C1-CBB225AE24F8.

[55] Among the groups that have called for a balanced preemption provision are the National Governors Association, National Conference of State Legislatures, American Association of State Highway and Transportation Officials, American Association of Motor Vehicle Administrators, and the Governors Highway Safety Association.

[56] Organizations calling for vehicle safety changes to the legislation include Advocates for Highway and Auto Safety, Citizens for Reliable and Safe Highways, Center for Auto Safety, Consumer Federation of America, National Consumers League, Trauma Foundation, and Truck Safety Coalition.

[57] Organizations seeking further cybersecurity amendments to S. 1885 include Advocates for Highway and Auto Safety, Center for Auto Safety, Public Citizen and League of American Bicyclists.

autonomous vehicle database that consumers and researchers could search by vehicle identification numbers (VINs).

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