Best Practices for
Regulation of

Autonomous Vehicles

on Utah Highways

Keeping Utah Moving

Report to the Utah Legislature
October 2016

Purpose

This report has been prepared in response to House Bill 280, passed during the 2015-16 Session of the Utah Legislature, which requires that the Department of Public Safety, in consultation with the Division of Motor Vehicles and the Department of Transportation, shall "study, prepare a report, and make recommendations regarding the best practices for regulation of autonomous vehicle technology on Utah highways." The legislation specifically required that the study shall include the following five elements:

(i) evaluation of standards and best practices suggested by the National Highway Traffic Safety Administration and the American Association of Motor Vehicle Administrators;
(ii) evaluation of appropriate safety features and standards for autonomous vehicles in the unique weather and traffic conditions of Utah;
(iii) evaluation of regulatory strategies and schemes implemented by other states to address autonomous vehicles, including various levels of vehicle automation;
(iv) evaluation of federal standards addressing autonomous vehicles; and
(v) recommendations on how the state should address advances in autonomous vehicle technology through legislation and regulation."

Background and Basics

There is broad consensus that the changes in transportation during the next five to 10 years will be the most disruptive changes since the invention of the automobile. At the center of the public dialogue surrounding this transformation is the prospect of fully autonomous, or "self-driving," cars. But the real trends are broader than just autonomous vehicles:

The changes in transportation over the next five to 10 years will be the most disruptive changes since the invention of the automobile.

Incremental vehicle automation, including features such as adaptive cruise control, braking assist, and self-parking, is already taking some aspects of vehicle control from the human driver.

Connected vehicle technology, where vehicles communicate with each other, with the infrastructure, and with other travelers, promises to significantly reduce vehicle crashes and crash severity.

Mobility services, such as Uber, Lyft and Car2Go, are expanding our options for travel, and will potentially impact levels of vehicle ownership, use of public transit, and design of urban spaces.

Demographic shifts, specifically our aging population, and generational attitudes, are also influencing the future of transportation. Nationwide, young people are increasingly choosing not to obtain drivers licenses.

Availability and use of transportation data, including traffic volumes and route congestion, an area that was once within the unique purview of government transportation agencies, is influencing transportation choices in unprecedented ways.

Although these trends are largely independent, and are being driven by entirely different forces, they are also synergistic. Each of them is influencing, and to some degree, driving the others.

In accordance with the statutory language requiring this report, the content of this document is specifically focused on autonomous vehicles. Before exploring the implications of the quickly changing landscape, it is important to understand some basic terminology and key players.

Current Events: New Federal Policy

The National Highway Traffic Safety Assocation (NHTSA) released a much-anticipated policy document "Federal Automated Vehicles Policy: Accelerating the Next Revolution in Roadway Safety" on September 20,2016. The policy is currently under a 60-day public review.

The document is less prescriptive than federal policies of the past and acknowledges the challenges of regulating an industry that is evolving rapidly:

"First, the rise of new technology is inevitable. Second, we will achieve more significant safety improvements by establishing an approach that translates our knowledge and aspirations into early guidance. Third, as this area evolves, the "unknowns" of today will become "knowns" tomorrow. We do not intend to write the final word on highly automated vehicles here. Rather, we intend to establish a foundation and a framework upon which future Agency action will occur."

Connected & Autonomous: A New Paradigm

Connected and autonomous vehicles have been viewed as separate, even competing, paradigms until recently. While the systems, goals and advantages are very different, many vehicle manufacturers are starting to incorporate both automated and connected features. The integration of these complementary technologies is becoming know as **connected automation** in **connected autonomous vehicles (CAVs)**.

Google car

Connected vehicle communications

Autonomous Vehicle (AV): Sometimes referred to as a "self-driving vehicle," (see following page) because a human driver is not needed. Performs safety-critical driving functions and monitors roadway conditions for an entire trip. While a human (who might be a rider, or might simply be sending the vehicle to a destination) may provide destination or navigational input, that person is not expected to be available for control of the vehicle at any time during the trip.

Connected Vehicle (CV): Connected vehicle technology was not intended to reduce or eliminate the driver's control of the vehicle. Connected vehicles utilize communications technologies and information from external sources to increase the driver's situational awareness. The connected vehicle provides information to the driver based on things it can "learn," using sources outside the vehicle.

Autonomous Technology and Vehicle Automation (AV): Vehicles that integrate both connected and autonomous technologies. Combining technologies within vehicles allows for safer, quicker and more efficient movement. This is achieved by allowing computer driven vehicles to "know" the conditions of the road network ahead, undertake rerouting based on new information (such as a lane closure) and warn vehicles behind of incidents – such as the need to avoid an obstacle.

How do they work together? For example, an autonomous vehicle "sees" that a traffic signal is red, yellow, or green through its digital camera systems; however, it does not know when that signal might change. A connected vehicle likely knows whether a signal is red, yellow or green, and also knows when it will change, because that information is broadcast by the signal system. If the automated sensor is obscured by another vehicle or sun glare or bad weather, the message received by the connected system would still know the condition of the traffic signal.

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Terms to Know

Connected vs. Autonomous

Autonomous vehicle	Performs safety-critical driving functions and monitors roadway conditions for an entire trip. While a human (who might be a rider, or might simply be sending the vehicle to a destination) may provide destination or navigational input, that person is not expected to be available for control of the vehicle at any time during the trip.
Connected vehicle	Connected vehicles utilize communications technologies and uses information from external sources to increase the driver's situational awareness. The connected vehicle provides information to the driver based on things it can "learn," using sources outside the vehicle.
Vehicle automation	Features that are automated to perform individual tasks. A car need not be fully, or even highly, autonomous to include some level of vehicle automation. • Adaptive cruise control (ACC) uses sensors to determine the distance to a vehicle ahead and automatically adjusts the following vehicle's speed to maintain a safe distance. • Lane keeping assist is another automated feature. In this case, the vehicle senses the lane markings and keeps the car centered in the lane. • Automated parking systems enable cars to parallel-park with no intervention from the driver.
Connected autonomous vehicle (CAV)	A vehicle that integrates both autonomous and connected technologies.
Highly automated vehicle (HAV)	This term was introduced in a recent NHTSA policy, and it refers to vehicles Level 3, 4 and 5 (see next page), which can operate independent of human control some or most of the time.
Driverless vehicle	The term "driverless" is sometimes used for autonomous vehicles, but this term isn't strictly correct. First, a driver might be present even though the vehicle is capable of self-driving. Additionally, there is some momentum for defining the driver as the computer system, the vehicle manufacturer, or the vehicle itself.
V2V	Vehicle-to-vehicle communication
V2I	Vehicle-to-infrastructure communication
V2X	Vehicle to pedestrian, cyclists, unknown object or other

Vehicle Technologies

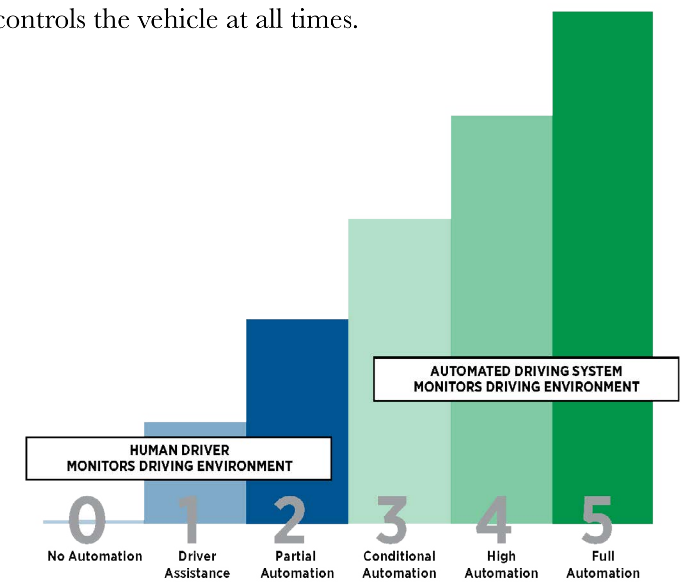
Global Positioning System (GPS)	A satellite-based navigational system that provides specific location (latitude, longitude, and elevation) and time at the receiver. For civilian applications, the accuracy of GPS locations is usually limited to a few feet.
Light Detection and Ranging (LiDAR)	A rotating beam of laser light, which determines the distance and direction to every object it encounters, creating a "point cloud." LiDAR is sometimes called "3-D laser scanning". In a moving vehicle, this 3D map is constantly being updated. Utah invested several years ago in LiDAR technology and is continually updating virtual mapping of the state and all its infrastructure.

Radar Sensors	Sensors mounted around the vehicle perimeter that detect objects.
Digital Cameras	Strategically mounted cameras that shoot digital images. The computer interprets these images. The on-board computer processes data from all of these devices, using redundant data from multiple sources to verify conditions. Essentially, the autonomous vehicle bases its decisions on things it can "see" using devices internal to the vehicle.
5.9 GHz DSRC	Dedicated short range communication (DSRC) is a short-rage radio transmission that uses the 5.9GHz band. This extremely low-latency bandwidth has been specifically allocated by the Federal Communications Commission (FCC) for transportation safety use. Data that is less time critical, such as warnings about congestion or low bridges, may be transmitted by cellular service.

Vehicle Automation Levels

The National Highway Traffic Safety Administration (NHTSA), an entity within the U.S. Department of Transportation, recently adopted a formal classification system for levels of vehicle automation. These levels are based on the Society of Automotive Engineers International (SAE) definitions. Previously, NHTSA and SAE had separate classification systems. The new classifications are as follows:

Level 0: The human driver completely controls the vehicle at all times.



Level 1: An automated system on the vehicle can sometimes assist the human driver conduct some parts of the driving task.

Level 2: An automated system on the vehicle can actually conduct some parts of the driving task; the human continues to monitor the driving environment and performs the rest of the driving tasks.

Level 3: An automated system can both conduct some parts of the driving task and monitor the driving environment in some instances, but the human driver must be ready to take back control when the automated system requests.

Level 4: An automated system can conduct the driving task and monitor the driving environment, and the human need not take back control, but the automated system can operate only in certain environments and under certain conditions.

Level 5: The automated system can perform all driving tasks, under all conditions. This is a fully autonomous vehicle.

With the adoption of this set of definitions, NHTSA has also defined the term "highly automated vehicle" (HAV) for vehicles that are classified as Level 3, 4, or 5. In the first three levels (0, 1 and 2), the human driver is primarily responsible to monitor the driving environment. In Level 3, there is the greatest degree of ambiguity because the automated system can perform driving and monitoring functions, but the human must be available to take over at any time. In Levels 4 and 5, the automated system is responsible

for both functionality and monitoring.

Agencies and Roles

The Federal Government, largely through the efforts of NHTSA, regulates vehicle systems and vehicle safety. NHTSA establishes the Federal Motor Vehicle Safety Standards (FMVSS) for new vehicles and enforces those standards though manufacturer certification and recall of non-compliant features. Historically, these requirements have facilitated adoption of significant safety features, such as air bags and anti-lock brakes. NHTSA issues guidelines for vehicle manufacturers and educates the public about safety issues.

State governments generally have jurisdiction over issues such as licensing and training of human drivers, registering motor vehicles, conducting safety inspections on those vehicles, enacting and enforcing traffic laws, traffic control, highway design and maintenance, crash prevention and investigation, emergency services, and regulating motor vehicle insurance and liability.

Vehicle Testing and Use

Much media attention has been focused on Google's autonomous vehicle efforts. Google has been testing their autonomous vehicles in closed courses and public streets for about seven years. They currently have almost 60 vehicles operating in Mountain View, California; Austin, Texas; Kirkland, Washington; and Phoenix, Arizona. Their stated intent is to offer a fully autonomous vehicle to the public by 2020, essentially entering the market at Level 4 or 5 automation. Nearly all of the traditional automakers are also developing automated features, and have offered certain features on some of their models. Their approach is more incremental, and includes connected and automated features, but is often focused on a fully autonomous vehicle as the end point. In mid-August, 2016, Ford announced that it plans to mass produce self-driving cars, with no steering wheels or pedals, and have them in commercial operation in a ridehailing service by 2021. Google also recently announced a partnership with Fiat Chrysler to transform some 2017 Chrysler Pacifica minivans into self-driving vehicles. In September 2016, Uber and Volvo began to deploy self-driving ride-sharing vehicles in downtown Pittsburgh. The Volvo vehicles have a person behind the wheel to take over in case the system fails to operate properly.

Peloton testing in Utah

Connected Automation is also an active force in transforming heavy truck transportation. Peloton, a Mountain View, California-based vehicle automation company has developed a system which facilitates platooning of two tractor-trailer rigs on the open highway. Connected vehicle technology allows the systems within the vehicles to communicate. Automated systems control acceleration and braking, so that the rear truck maintains an exact distance behind the front truck and responds instantly to changes in speed of the front truck. Both drivers still steer, but the systems keep the trucks about 50 feet apart, allowing the trucks to draft off of each other. The efficiency of air flow results in a savings of about 5 percent for the front truck and 10 percent for the rear truck. During the 2015 session, the Utah Legislature adopted HB 373, which provided for testing of this technology on Utah roads. In the fall of 2015, Peloton demonstrated their platooning system along I-80 near Tooele.

Legislative and Policy Implications

A recent guide for government agencies, *Driving Towards Driverless* by Lauren Issac, states that "Driverless vehicles will likely have a huge impact on our future; however, it is the government's actions (now and in the future) that will determine how they are integrated into society and whether the impacts are largely positive or negative." The former director of Google's self-driving car project, Chris Urmson, told members of the U.S. Senate Committee on Commerce, Science and Transportation that an array of state laws would create an "unworkable situation" that would "hinder safety, innovation, interstate commerce, national competitiveness and the eventual deployment of autonomous vehicles." [March 15, 2016 testimony, "Hands Off: The Future of Self-Driving Cars"]

Utah is home to several nationally recognized experts in the connected and autonomous transportation industry. Other states, however, have invested more heavily in testing facilities and partnerships with academic and private industry innovators. Among the states that are currently leading the way with vehicle testing and public-private partnerships are Michigan, California, Iowa, Florida and Nevada.

Utah has several strengths that could facilitate opportunities for testing of connected vehicle technology. This may be a potential area to foster economic development; it could also generate firsthand insight into the needs and wants of private industry in relation to policy creation and development. Utah can leverage and build upon the following advantages:

- Nearly 90 percent of Utah's traffic signals are already on a centralized system for operation and synchronization. This type of centralization is key to effective connected autonomous vehicle functionality.
- Utah has invested for more than 10 years in the installation of a fiber optic backbone in highway right of way. This will help enable rapid implementation of connected vehicle communications statewide.
- With the youngest median age in the country, our demographics lend well to providing a market that is likely to be accepting to disruptive technology.
- The growing technology industry in Utah is developing and expanding a talent pool that may be attractive to manufacturers.
- Utah has mapped its roadway infrastructure using LiDAR technology and is currently implementing 3D design and 3D construction on several projects. Our state is utilizing technologies that will be foundational for successful connected vehicle adoption.

During the past several years, seven states and the District of Columbia have passed legislation or regulations relative to autonomous vehicle operations (see map on next page). The nature of these regulations vary significantly. Further discussion and analysis of existing legislation is included in this report on page 12 (Analysis of Existing Legislation: Other States).

National Guidance

NHTSA began issuing formal statements about automated driving systems as early as May 2013. In one such statement, NHTSA indicated that "three distinct but related streams of technological change and development are occurring simultaneously: (1) in-vehicle crash avoidance systems that provide warnings and/or limited automated control of safety functions; (2) V2V communications that support various crash avoidance applications; and (3) self-driving vehicles.

> *"The governing principle should be that technologies with proven data-supported benefits that would make safer roads should be encouraged."*
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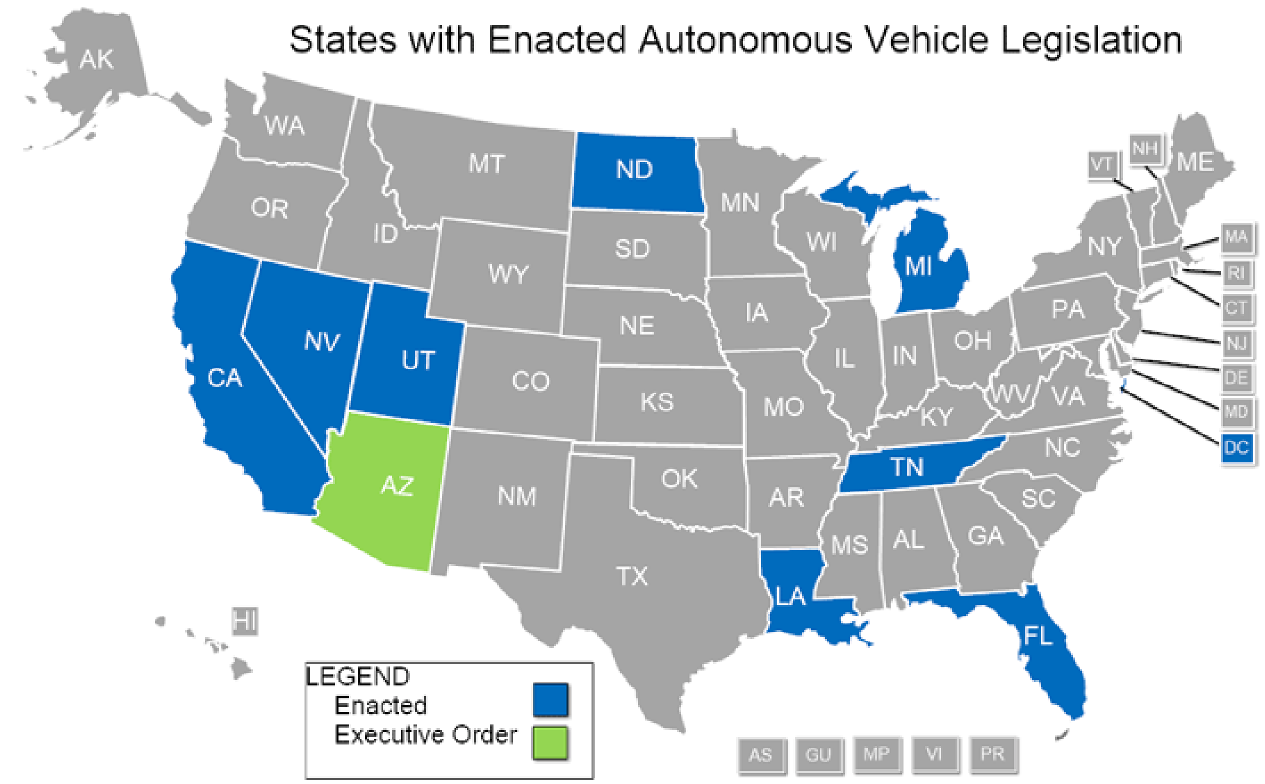
> *- NHTSA Policy Update (Jan. 14, 2016)*



"In general, we believe that states are well-suited to address issues such as licensing, driver training, and conditions for operation related to specific types of vehicles. NHTSA has considerable concerns however about detailed state regulation on safety of self-driving vehicles. . . NHTSA does not recommend that states attempt to establish safety standards for self-driving vehicle technologies, which are in the early stages of development." [NHTSA Preliminary Statement, 2013]

In early 2016, NHTSA went on to state a foundational principle for moving these technologies forward: "For policymakers at all levels, the governing principle should be that technologies with proven, data-supported benefits that would make roads safer should be encouraged." [NHTSA Policy Update, Jan 14, 2016]

On April 27, 2016, NHTSA Administrator Mark R. Rosekind, Ph.D., discussed the reasons that NHTSA has been working to develop autonomous vehicles policies: "Why is the Department of Transportation pressing ahead so deliberately on automated vehicle technology policies, when a lot of people say the technology is not ready for the road? Here's the answer: the technology is already on the road. Safety technologies like automatic emergency braking, lane-assist and adaptive cruise control are already in the cars that many of you drove in here today. Higher levels of automated vehicle technology are being tested on U.S. roads as we speak."

NHTSA's much awaited policy guidance, "Federal Automated Vehicles Policy: Accelerating the Next Revolution in Roadway Safety," was released on Sept. 20, 2016. Citing the promise of great improvements in safety and mobility, the NHTSA Policy "sets out an ambitious approach to accelerate the HAV revolution."

The document focuses primarily (but not exclusively) on HAVs that will operate on public roads and has four major components: Vehicle Performance Guidance for Automated Vehicles, Model State Policy, Current Regulatory Tools, and Modern Regulatory Tools.

Vehicle Performance Guidance for Automated Vehicles

The guidance for manufacturers, developers and other organizations outlines a 15-point "safety assessment" for the safe design, development, testing and deployment of automated vehicles. Entities producing automated vehicles and components will be expected to provide reports to NHTSA on how their components perform in the following areas:

- Data Recording and Sharing
- Privacy
- System Safety
- Vehicle Cybersecurity
- Human Machine Interface
- Crashworthiness
- Consumer Education and Training
- Registration and Certification
- Post-Crash Behavior
- Federal, State and Local Laws
- Ethical Considerations
- Operation Design Domain
- Object and Event Detection and Response
- Fall Back (Minimal Risk Condition)
- Validation Methods

Model State Policy

NHTSA describes a clear distinction between Federal and State responsibilities for regulation of HAVs, and suggests recommended policy areas for states to consider with a goal of generating a consistent national framework for the testing and deployment of HAVs. These policy recommendations were developed in conjunction with the American Association of Motor Vehicle Administrators (AAMVA) and other safety stakeholders. The proposed policy framework covers the following areas:

- Administrative structure and processes for the use of public roads for HAV testing and deployment
- An application process to be used by manufacturers
- Jurisdictional permission for testing
- Testing by the manufacturer or other entities
- Drivers of deployed vehicles
- Registration and titling of deployed vehicles
- Law enforcement considerations
- Liability and insurance issues

Recommendations proposed later in this paper come largely from this NHTSA proposed regulatory framework. NHTSA notes that although states regulate human drivers, as motor vehicle equipment increasingly performs "driving" tasks, NHTSA's exercise of its authority and responsibility to regulate the safety of such equipment will increasingly encompass tasks similar to "licensing" of the non-human driver. [NHTSA Policy, p38]

Current Regulatory Tools

NHTSA outlines their current regulatory tools that can be used to accelerate the safe deployment of HAVs, such as interpreting current rules to allow for greater flexibility in design and providing limited exemptions to allow for testing of non-traditional vehicles designs in a more timely fashion.

Modern Regulatory Tools

NHTSA identifies potential new regulatory tools and statutory authorities that may aid the safe and efficient deployment of new lifesaving technologies. As one example, NHTSA proposes to use pre-market approval authority, a departure from their current manufacturer self-certification system. An ability to regulate post-sale software changes in HAVs is another example. NHTSA also signals their intent to require data recorders to monitor the performance of HAVs, and describes the conceptual framework for gathering that data.

It is important to note that NHTSA plans to gather public feedback on this guidance, and intends to update the guidance frequently (as often as annually) as technology progresses.

Additional National Guidance

The American Association of Motor Vehicles Administrators (AAMVA) has established an Autonomous Vehicle Best Practices Working Group to prepare a best practices guide to assist member jurisdictions in regulating autonomous vehicles and testing the drivers who operate them. They are in the process of gathering information related to the development, design, testing and use of autonomous vehicles. At this point, the AAMVA Working Group has not issued any guidance.

The National Association of City Transportation Officials (NACTO) has issued a policy statement on automated vehicles that states, "Fully automated vehicles are a disruptive technology that will have widespread impacts on safety, mobility, land use, labor, and the built environment. Considering the complexity of urban environments and the many demands placed on city streets, as well as existing city policy goals of reduced greenhouse gas emissions and vehicle miles traveled, NACTO supports automated vehicle policies and regulations designed to:

- Promote safety for pedestrians, bicyclists, transit riders, automated vehicle passengers, and all street users within the multi-modal urban context;
- Incentivize shared, automated, electric vehicles to reduce the environmental impacts of vehicular travel and refocus planning on the principle of mobility as a service;
- Support the future vision of communities as great places to live, work, and play by using technology as a tool to change land use as well as how streets are built;
- Re-balance the use of the right-of-way with less space for cars and more space for people walking, cycling, using transit and recreating;
- Support public transit by providing first and last mile connections to major transit lines via shared, automated vehicles, and by providing cost-effective, on-demand transit in lieu of low-performing fixed routes; and
- Improve mobility for all, contributing to a more equitable transportation system, where benefits reach all demographics and any negative effects are not unjustly concentrated.

Utah Roads and Weather Conditions

Regulation of all motor vehicles and standards falls within the jurisdiction of NHTSA. Most manufacturers of HAVs have not yet tested their systems in winter weather, but that testing phase will come in the future. The recent NHTSA policy proposes to require manufacturers to identify the Operational Design Domain (ODD) for each vehicle automation feature. It is conceivable, then, that a manufacturer could specify a particular function in a Level 3 or 4 vehicle as inappropriate for use in snow-covered roads or other similar conditions.

Within this framework, it is conceivable that the State could enact regulations about where and when certain kinds of HAVs can operate based on these ODDs, once they are in place for all vehicles. For instance, the State could require that before an HAV could operate on snow-covered roads at night, the vehicle would have to have filed the appropriate certificates with NHTSA identifying capabilities within appropriate ODDs.

Analysis of Existing Legislation

The issues to be considered are too varied and fluid to enumerate, so the following analysis is not to be taken as a comprehensive evaluations of legislative issues in Utah or around the country. This report focuses on some specific issues that merit attention and useful information gleaned from other states.

Utah Code and Definitions

There has been considerable national discussion about the nuances of typical "driving" legislation and how "self-driving" motor vehicles fit into the legal framework. In one comprehensive discussion, Bryant Walker Smith ("Automated Vehicles Are Probably Legal," p463, 2014) notes that "no state statute expressly requires that a vehicle have a driver" and concludes that (p516) "current law probably does not prohibit automated vehicles – but may nonetheless discourage their introduction or complicate their operation." Utah Code defines a driver as a "person who. . . is in physical control", but is silent on whether a vehicle must have a driver or whether something that is not a "person" can be the driver.

In a recent response to regulatory questions raised by Google, NHTSA responded that "if no human occupant of the vehicle can actually drive the vehicle, it is more reasonable to identify the 'driver' as whatever (as opposed to whomever) is doing the driving. In this instance, an item of motor vehicle equipment, the SDS, is actually driving the vehicle." The SDS referred to here is the "self-driving system" used to control the Google vehicles. In essence, the federal government, by this response, indicated that the computer can be the "driver."

More recently, NHTSA declared that "if a vehicle is compliant within the existing FMVSS regulatory framework and maintains a conventional vehicle design, there is currently no specific federal legal barrier to an HAV being offered for sale." ["Federal Automated Vehicles Policy: Accelerating the Next Revolution in Roadway Safety", September 20, 2016, p.11]

Examining Definitions: "Physical Control" in Utah Case Law

The State of Utah has long-standing case law pertaining to the definition of physical control of a vehicle. In cases such as **Lopez v. Schwendiman** (1986) and **Garcia v. Schwendiman** (1982), there has been a precedent for holding impaired drivers accountable to the law even when they are simply seated behind the wheel of a parked car.

These examples add further complexity to the question of where the vehicle's responsibility ends and where the driver's begins. Even in considering Level 4 and 5 vehicles, which can drive without human monitoring under most conditions, there is some need for evaluation of when and whether a human should ever manually assume control. There is also a need to determine the level of ability and judgment required of the human. Even more ambiguous are Level 3 vehicles, which are essentially a hybrid wherein the car can drive itself most of the time, but the human driver must actively monitor the driving environment. These issues will influence policy, licensing, training, citations, crashes and arrests.

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There are various references in Utah Code to drivers and the physical control of motor vehicles. The following provisions are relevant to the subsequent discussions about policy issues:

- 53-3-102.14a – "drive" is defined as "to operate or be in physical control of a motor vehicle upon a highway."
- 52-2-102.15a – "driver" is defined as "any person who drives, or is in actual physical control of a motor vehicle in any location open to the general public for purposes of vehicular traffic."
- 41-6a-102 (40) – "operator" is defined as a person who is actually in physical control of a vehicle.
- 53-3-104.3 – (Driver License) Division has authority to "license motor vehicle drivers."
- 53-3-202.1a – "A person may not drive a motor vehicle or an autocycle on a highway in this state unless the person is granted the privilege to operate a motor vehicle by being licensed as a driver."

Legislators may consider examining definitions of "drive" and "operator" and existing statutory references to these terms. This foundational language has a strong influence on the expediency and ease of HAV adoption in our state.

Other States

Nevada

NV SB511 (June 17, 2011)
Nevada was the first state to authorize the operation of autonomous vehicles in 2011. Nevada legislation defines "autonomous vehicle," authorizes operation of autonomous vehicles and a driver's license endorsement for operators of autonomous vehicles, and directs the DMV to adopt rules for license endorsement, operation, insurance, safety standards and testing.

NV SB140 (June 17, 2011)
Permits persons in autonomous vehicles to use cell phones, implying that these persons are not "operating" a motor vehicle.

NV SB313 (June 2, 2013)
Requires autonomous vehicles to meet certain safety criteria and specifies relationships to human operator.

Florida

FL HB1207 and FL HB599 (Apr. 16, 2012)
Defines "autonomous vehicle" and "autonomous technology" and declares legislative intent to encourage safe development, testing and operation of autonomous vehicles. It does not prohibit or specifically regulate autonomous vehicles.

FL HB1207 (Apr. 16, 2012)
The bill authorizes a person who holds a valid driver's license to operate an autonomous vehicle and defines who the "operator" is.

Certain agencies are directed to prepare a report recommending legislative or regulatory action.

FL HB7027 (Apr. 4, 2016)

Modifies some requirements about vehicle operation and eliminates the requirement that a driver be present in the vehicle. The bill further requires autonomous vehicles to meet applicable federal standards and regulations.

FL HB7061 (Apr. 14, 2016)

Defines driver-assisted truck platooning technology, requires a study of the safe operation of this technology, and allows for a pilot project.

California

CA SB1298 (Sep. 25, 2012)
Requires the Highway Patrol to adopt safety standards and performance requirements for the safe operation of autonomous vehicles and permits autonomous vehicles to be operated or tested on public roads pending these safety standards.

Louisiana

LA HB1143 (June 2, 2016)
Defines "autonomous technology" for purposes of highway regulatory provisions. The term "autonomous technology" is defined as "technology installed on a motor vehicle that has the capability to drive the vehicle on which the technology is installed in high- or full-automation mode, without any supervision by a human operator, with specific driving mode performance by the automated driving system of all aspects of the dynamic driving task that can be managed by a human driver, including the ability to automatically bring the motor vehicle into a minimal-risk condition in the event of a critical vehicle or system failure, or other emergency event."

Michigan

MI SB169 (Dec. 20, 2013)
Provides definitions and expressly permits testing of autonomous vehicles under certain conditions, addresses liability issues for manufacturers, and directs the DOT to submit a report.

MI SB663 (Dec. 20, 2013)
Provides additional detail on manufacturer liability. In 2016, at least six additional bills have been introduced that prohibit intentionally accessing a vehicle's computer system without permission, authorizing autonomous vehicle operation beyond testing, authorizing platooning, establishing a Council on Future Mobility, and other things.

North Dakota

ND HB 1065 (Mar. 20, 2015)
Certain agencies are directed to prepare a report recommending additional legislative or regulatory action.

Tennessee

TN SB 598 (Apr. 24, 2015)
Prohibits local governments from banning the use of autonomous technology.

TN SB 2333 (Mar. 22, 2016)
Allows motor vehicles to be operated with an integrated display during autonomous testing.

TN SB 1561 (Apr. 27, 2016)
Establishes a certification program for manufacturers of autonomous vehicles which must be met before testing is initiated. An autonomous vehicle tax structure was also created.

Licensing

Because the responsibility for licensing falls to the states, Utah will need to update driver education and training regarding autonomous vehicles. NHTSA is researching how drivers stay engaged while HAVs are performing all or part of the driving tasks.

In order to make the transition from human-driven motor vehicles equipped with automated safety technologies to fully automated vehicles, gaps in current regulations should be identified and addressed by the states (with the assistance of NHTSA). Some examples are:

- Law enforcement/emergency response
- Occupant safety
- Motor vehicle insurance
- Crash investigations/crash reporting
- Liability (tort, criminal, etc.)
- Motor vehicle safety inspections
- Education and training
- Vehicle modifications and maintenance
- Environmental impacts

California Test Driver Requirements

Test Driver Selection and Training
Effective autonomous vehicle testing safety program begins with test driver selection and training. Potential test drivers should be screened for a safe prior driving record, and the criteria for a safe driving record should be at least as stringent as the criteria for obtaining and maintaining a commercial vehicle driver's license, given the obvious parallels; however, the details of the driver training program can vary depending upon the specific autonomous vehicle concept and the scope of the testing to be conducted

Graduated Qualification Levels
A good training program will recognize the need for graduated test driver qualification levels associated with testing systems with different levels of maturity, so that the least experienced drivers only test the systems that are the most mature and the more experienced drivers would test the systems that are technically less mature and considered more unpredictable or risky.

The training program should include:

- Familiarization with the automated driving system technology.
- Basic technical training regarding the system concept.
- Capabilities, and limitations.
- Ride-along demonstrations by an experienced test driver.
- Subsequent behind-the-wheel training.

Behind-the-wheel training should be conducted while the trainee is accompanied by an instructor, first on test tracks and then on public roads, so that the instructor can verify the test driver trainee's driving skills and judgment.

Some programs include commercially available defensive driving school training, but it is not sufficient to qualify a test driver, nor is it necessarily required. Follow are criteria for test drivers:

- No DUI, not an at-fault driver, and cap on points.
- Successful completion of test driver training program.

- Employee, contractor, or designee of manufacturer.
- Test driver must be seated in driver seat during testing.
- Report any crashes within 10 days. ·
- Report unanticipated disengagements of autonomous technology annually.
- Testing permit valid for one year.
- Vehicles excluded from testing: Commercial vehicles that are > 10,000 lbs GVW and motorcycles.

California has strict rules about who can pilot the dozens of experimental autonomous vehicles cruising its public roads. Prospective test drivers have to pass a defensive driving course, have near-spotless records, and have at least a decade without a drunk-driving conviction. Crucially, they must also complete a special training program for autonomous vehicles.

Manufacturers – Training Programs
Autonomous training programs vary considerably in content, intensity, and duration. Manufacturers are allowed to design and conduct their own autonomous training programs. California law requires the courses to feature behind-the-wheel lessons and information about automated technologies, including their limitations. What the regulations do not mention are specific procedures to teach or goals to meet, nor how long any such training must last.

Company	Extra Time for Training
Volkswagen/Audi	2 hours or less
Delphi	1 day
Nissan	1 day
Google	5 weeks (plus in-car observations, hands-on sessions, and evaluations)
Tesla	Undisclosed (likely half a day)
Bosch	Undisclosed (likely one day)
Mercedes-Benz	Undisclosed (likely one day)

Source: IEEE http://spectrum.ieee.org/car-that-think

Nevada

The test license applicant must provide proof to the Department that:

- The holder is an employee of the test license holder.
- The holder has completed no less than 50 hours of training in an autonomous vehicle.
- May include no more than 10 hours of operation of an autonomous vehicle simulator.
- Must include no less than 40 hours of operation of an autonomous vehicle on any paved, graded, or similar surface, including a race track or private course.
- Any other information the Department may request.

Washington – Draft Legislation for Testing

- The manufacturer is conducting the testing and all test drivers are or will be employees, contractors, or designees of the manufacturer.
- Test drivers will be trained in the manufacturer's Test Driver Training Program.
- Test drivers will sit in the driver's seat and either manually control the vehicle or actively monitor the vehicle's operations and be capable of taking immediate physical control.
- The test driver is required as a condition of their employment or contract to obey all provisions of the Vehicle Code and local regulation applicable to the operation of motor vehicles, whether the vehicle is in autonomous mode or manual mode.
- The manufacturer ensures the test driver knows the limitations of the vehicle's autonomous technology and is capable of safely operating the vehicle in all conditions under which the vehicle is tested on public roads.

Requirements for Test Driver Certification
A manufacturer shall not allow any person to act as an autonomous vehicle test driver for testing autonomous vehicles on public roads unless manufacturer has certified to the department that each of its test drivers meets the following requirements:

- The test driver has completed the manufacturer's autonomous vehicle Test Driver Training Program and received a certificate of completion from the manufacturer.
- The test driver has been licensed to drive a motor vehicle for the three years immediately preceding application to the Department, and at that time the driver:
  - Was not the at-fault driver of a motor vehicle involved in a crash that resulted in injury or death of any person.
  - For the 10 years immediately preceding application to the Department was not convicted for driving or operating a vehicle under the influence of alcohol or any drug, and did not suffer any driver license suspension or revocation for driving a vehicle under the influence of alcohol or any drug.
- The manufacturer has identified the autonomous vehicle test driver to the Department in writing, providing the driver's full name, his or her driver's license number, and the jurisdiction of issuance of the license.
- The manufacturer has submitted the course outline of the Test Driver Training Program to the Department and the Department has approved the program. The program must include the following elements:
  - Instruction on the automated driving system technology to be tested in the manufacturer's vehicles, including behind-the-wheel instruction provided by an experienced driver on the capabilities and limitations of the manufacturer's automated driving systems. For the purposes of this section, an "experienced automated driving systems. For the purposes of this section, an "experienced driver" is one who through training and experience has developed skill and knowledge in the operation of the manufacturer's autonomous technology.
  - Defensive driver training, including practical experience in recovering from hazardous driving scenarios.

Vehicle Titles and Registration

NHTSA regulates the performance of motor vehicles, in part through the promulgation and enforcement of rules, including the performance-based standards to which manufacturers, importers, and distributors must certify their new vehicles. Neither Federal Motor Vehicle Safety Standards (FMVSSs) nor NHTSA's other rules appear to directly preclude the sale or importation of automated vehicles. These rules, for example, assume but do not expressly require the presence of a driver (defined as 'the occupant of a motor vehicle seated immediately behind the steering control system'). (Smith, Automated Vehicles are Probably Legal, p458)

As indicated in the recent NHTSA Policy, NHTSA intends to apply those same regulations, and some new ones, to HAVs. Among other things, they propose to add requirements for the motor vehicle title and registration to have an "HAV" indication in a new data field for vehicles that can be operated without a human driver. [NHTSA Policy, p 44] They also propose that, for crash reconstruction purposes and acceleration of performance knowledge, HAVs should store operational data that can be retrieved by the manufacturer or NHTSA. [NHTSA Policy p 17-18] While these new policies are intended largely for HAVs, NHTSA indicates that some elements should apply to the full spectrum of automated vehicle systems. [NHTSA Policy, p 31]

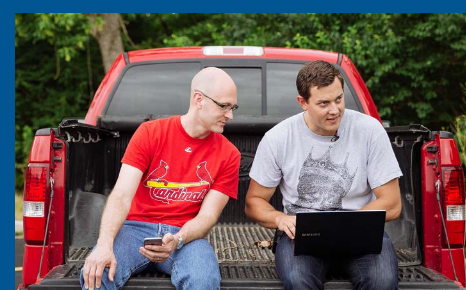
Connected and Autonomous Vehicles in the News

Several recent events highlight the unknowns of this rapidly changing industry. They also bring forward issues for policymakers, manufacturers and the public to discuss and consider.

Jeep Hack: System and Software Security

For example, in 2015, two online security specialists, Charlie Miller and Chris Valasek, conducted a widely publicized demonstration to show that they were able to hack into a 2014 Jeep Cherokee through its onboard entertainment system and control it remotely.

The story generated heated public dialogue about conerns regarding driver safety and security and spurred Chrysler to develop improvements to the security of their system. Miller and Valasek now work for Uber Technologies, and continue to work at exposing vulnerabilities of autonomous technology systems for the purpose of identifying needed fortifications. In 2016, they conducted a follow-up demonstration, using different methods to hack the same 2014 Jeep Cherokee.



Top: Hackers Miller and Valasek. Bottom: The 2014 Jeep Cherokee was used in both the 2015 and 2016 hacking demonstrations.

Chrysler defended their advancements in security, pointing out that Miller and Valasek hacked an outdated version of their sytem; they also clarified that the hackers were only able to influence limited functions of the vehicle.

These instances, though somewhat sensationalized by media coverage, highlight a legitimate concern: like all technological innovation, autonomous technologies will create unforeseen issues and vulnerabilities. There will be a constant evolution of refining software and systems.

From a policy perspective, this also raises questions as to how offenses such as hacking should be addressed. Are manufacturers liable for allowing vulnerabilities? How should hacking offenses be categorized and punished? What are best practices for mitigating the risk of hacking, and should that be managed by private industry or regulated by the government?

Some discussion of the legal implications of vehicle hacking are currently taking place in other states, such as Nevada, and at a national level. The agencies involved with the development of this report will continue to monitor developments and engage in national conversation.

Report to the Utah Legislature
Best Practices for Regulation of Autonomous Vehicles on Utah Highways

Car Crashes: Risks and Rewards of Technology

According to NHTSA research, 94 percent of vehicle crashes are caused by human error. Autonomous vehicles represent a tremendous opportunity to decrease the number of crashes on our roads and potentially eliminate thousands of fatalities each year; however, recent high-profile crashes involving autonomous vehicles illustrate risks in the process of achieving that goal.

Google car crash February 2016.

Google self-driving vehicles have been testing on public roads since 2009. In those seven years, Google has logged more than 4 millions miles with about 1.6 million miles in autonomous mode. During this time, Google has reported 20 crashes, 12 of which occurred when the car was in autonomous mode. That translates to a rate of about 7.5 crashes per million miles, or 2.5 times the national rate for property-damage-only crashes. All but one of these 20 crashes were determined to be the fault of other drivers; 15 of the crashes involved a human-controlled vehicle hitting the back of the Google vehicle.

On Feb. 14, 2016, the first crash actually caused by the self-driving vehicle was reported. Damage was minor and Google announced that this gave their software developers useful information on how to tweak their control algorithms.

In a more publicized case, a Tesla Model S vehicle was involved in a fatal crash in Florida on May 7, 2016. This is the first known fatal crash involving an automated vehicle system. The car was using a Tesla system known as "Autopilot," which is the first commercially available Level 2 system. Autopilot allows the driver to relinquish control of the vehicle speed, braking, and lane changing in a freeway setting; this mode was not designed for use in a setting with cross-traffic. In this crash, a commercial truck turned left in front of the Tesla, which failed to initiate braking. In this case, Autopilot was engaged on a highway that allowed cross-traffic, and it has been unofficially reported that the driver was utilizing a tablet at the time of the crash. Both Tesla and NHTSA have opened investigations into the circumstances of this crash.

The director of NHTSA, Dr. Mark Rosekind, noted that tthese incidents provide "an enormous opportunity for learning." These situations can be analyzed and shared. He added that such incidents will not derail the efforts of NHTSA to improve safety on the roads.

Dr. Rosekind noted that we lost 32,500 lives on our roads last year, and that we are desperate for new tools to save lives. "Of course we have to do everything we can to make sure new technology does not introduce new safety risks, but we also can't stand idly by while we wait for perfect."

Recommendations and Considerations

The primary recommendation of this report is that the State continue studying the issues surrounding HAVs as the landscape continues to rapidly evolve. While it may be premature to implement new policies or adopt new legislation at this time, a committee or council with issue-specific subcommittees may be a an effective approach for research and ongoing dialogue. In fact, one of the recommendations from the recent NHTSA policy is to "consider establishing a statewide Automated Safety Technology Committee, led by the designated agency, to monitor progress of automated technologies and associated regulations."

If such a committee were to be created, some of the specific issues to research and consider are listed below:

Vehicle safety
While NHTSA has final jurisdiction over vehicle safety regulation, Utah should remain engaged in national executive committees and research. These organizations help inform and influence NHTSA.

Data security
With the high volume of data to be captured, exchanged and potentially stored, data security issues continue to arise and evolve. They can be broadly categorized into the following three categories for research and consideration:

- Personal privacy - Access to and utilization of individual and aggregate driver information.
- Hacking - Safety concerns, legal liability/responsibility, and industry best practices.
- Crash investigation - Law enforcement access to "black box" information or stored driver information.

Infrastructure preparation
Evaluate variations in highway infrastructure, including signs, traffic signals and lights, and pavement markings, to insure consistency in style and quality.

Understand current fiber optic telecommunications capacity and infrastructure compared with future needs.

Training and licensing
Develop proposals for potential future statutory language to implement a framework for regulations and requirements in driver education and training. In doing this, consideration will need to be given to the different regulatory environments associated with "testing" of HAVs as opposed to "deployment."

Issues for consideration by policymakers:

- Appropriate minimum standards for HAV test driver selection and training.
- Manufacturer training programs that meet the minimum standards set by DLD.
- Test drivers will be required to be an employee of the entity conducting the HAV testing.
- Testers will be required to obtain a Utah permit with the required HAV endorsement (all required training complete).

Driver License considerations for HAV vehicles:

- Continued licensing when a driver is required or capable of taking manual control of the vehicle.
- Persons operating an SAE levels 0,1, 2, and 3 should have a valid driver license.
- Licensing and/or operator requirements for SAE Levels 4 and 5.

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Vehicle registration
Evaluate registration options for various types of vehicles (i.e. computer systems, vehicles, manufacturers, human drivers) and vehicles (levels 1 through 5).

Develop proposals for potential future statutory language to implement a framework for regulations.

Enforcement
Consider modification in laws and regulations to designate an HAV system that operates in Levels 3, 4 and 5 as the "driver" of the vehicle.

Identify needed updates to citation and crash report documents and databases, which will need to include new definitions of drivers and systems.

Training for law enforcement to use new form and crash investigation methodology.

Develop proposals for potential future statutory language to implement a framework for regulations regarding insurance and liability.

Ensure systems for detecting and yielding to enforcement vehicles.

Regional and national consistency

Engage in national conversations about the gaps in regulations pertinent to the transition from human-driven vehicles to fully automated vehicles, specifically as they apply to law enforcement, emergency response, motor vehicle insurance, crash investigations, liability, and safety inspections.

Collaborate with other states and national groups to stay abreast of developing norms and recommendations.

A committee such as this has been created in Pennsylvania; the Utah group should communicate with the Pennsylvania committee to generate ideas for study and gather lessons learned.

Policy considerations

In addition to the technical research and reporting to be completed by the committee described above, there is a need for discussion of policy, goals and strategies related to this industry and its potential opportunities for the State.

Among the questions policymakers may consider are the following:

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