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HOW LOCAL GOVERNMENTS CAN PLAN FOR DRIVERESS VEHICLES

Driverless vehicles have the potential to change all aspects of mobility – from driver safety and insurance liability to car ownership and how people commute. It has the potential to disrupt both public and private transportation as we know it. As Google, Uber, the automobile industry, and other organizations continue to make rapid technological advances, it is vital that federal, state, and local governments establish policies, laws and regulations that account for these disruptions. Of utmost importance is finding a balance between guarding public safety while regulating insurance/liability and still encouraging investment in research and development of driverless vehicles. This paper outlines the role of government in driverless vehicles and present information local and regional governments need to inform planning and decision-making – both now and in the future.

1. Introduction

Fully automated vehicles (AVs), also referred to as driverless cars or self-driving cars, are capable of sensing their environment and navigating roads without human input. As a sub-category of automated vehicles, they rely on technologies like GPS, LIDAR, and radar to read their surroundings and make intelligent decisions about the car's direction and speed and interaction with other road users.

Both the National Highway Safety Administration (NHTSA) and SAE International have defined levels of vehicle automation, ranging from driver assistance for a single vehicle function, to full automation with no driver required. The focus of this paper is on the highest level of automation: fully automated vehicles (or "driverless cars"). NHTSA's highest level of automation (Level 4), also referred to as "full self-driving automation" is defined as: *"designed to perform all safety-critical driving functions and monitor roadway conditions for an entire trip. Such a design anticipates that the driver will provide destination or navigation input, but is not expected to be available for control at any time during the trip."* SAE defines its highest level of automation (Level 5) as the "*full-time performance by an automated driving system of all aspects of the dynamic driving task under all roadway and environmental conditions that can be managed by a human driver*."

2. Proposed Government Role in Driverless Vehicles

The following section describes the aspects of driverless vehicles that will likely require government involvement now or in the future. As shown in the graphic below, the federal government will likely need to update, establish, and enforce policies and regulations around safety, privacy/data sharing, and cyber security, in addition to establishing and enforcing standards. On the other hand, state and local governments will need to update, establish, and enforce policies and plans around mobility, infrastructure, transit, and financials.

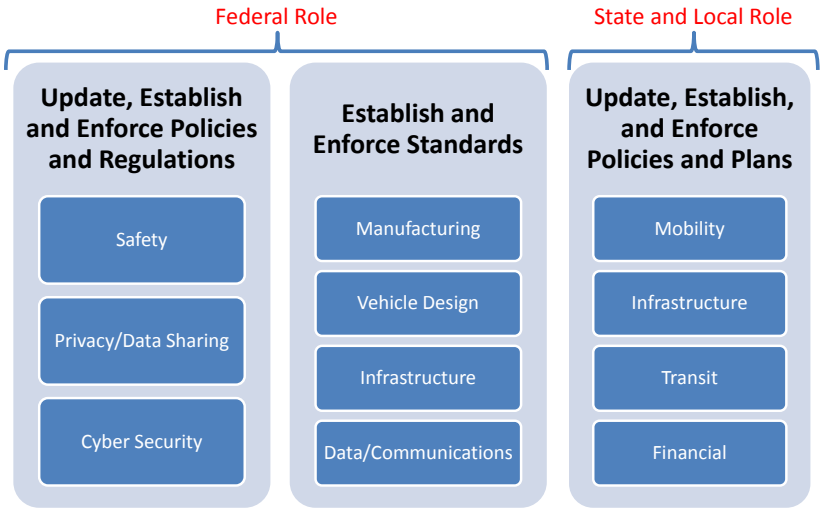

Figure 1 – Proposed Government Role in Driverless Vehicles

This maintains the government's role of protecting individuals' safety and improving mobility around the country.

2.2 Proposed Federal Government Role in Driverless Vehicles

It is crucial that the federal government proactively establishes policies and regulations for driverless vehicles to ensure that passengers and bystanders are safe, but also because it is inefficient, costly, and confusing for all stakeholders to familiarize themselves with multiple, disparate state laws. The following are a range of issues that are most appropriately addressed at the national level:

- Safety. The federal government should lead the charge in establishing (or updating existing) safety standards for driverless vehicles, similar to those already in place by the Federal Motor Vehicle Safety Standards and Regulations. Specifically, the federal government could establish standards around manufacturing, vehicle design, infrastructure, and all aspects of data and communications - all with the intent of maintaining safety on our roadways.
- Privacy/Data Sharing. Because driverless vehicles will gather a large volume of data to operate most effectively, there are significant concerns about data ownership, collection and use. The federal government should, as it has with other data-rich industries, require that the driverless vehicle industry is secure and transparent with consumers about data ownership, storing, sharing, and security breaches.
- Cyber Security. Driverless vehicles could be targets for terrorists, and an attack carries the risk of significant, coordinated traffic disruptions or collisions. The National Institute of Standards and Technology (NIST) is currently developing a framework to improve critical infrastructure cyber security[1] and it is vital that the government ensures that this encompasses the risks associated with driverless vehicles.

It should be noted that many of the issues described above are relevant for connected vehicles as well.

[1] http://www.enotrans.org/wp-content/uploads/wpsc/downloadables/AV-paper.pdf, August 4, 2014

2.3 Proposed State, Regional, and Local Government Role in Driverless Vehicles

Driverless vehicles have the potential to impact states and municipalities in a number of ways: traffic congestion and tax revenues may increase or decrease, current public transit options may need to become more competitive, parking needs may decrease, and roadway infrastructure may need to be adapted (to name a few). Local governments will need to plan for these many changes.

Depending on the governance model utilized in a particular region, different local entities will have jurisdiction over driverless vehicles. These local, regional, and state government entities may include transit agencies, metropolitan planning organizations, air quality districts, departments of transportation, highway departments, and departments of public works.

The following are a range of issues that are most appropriately addressed at the local level:

- Mobility. There are many factors that will influence the level of congestion within and around our cities. The level of ride sharing and the competitiveness of public transportation will be significant factors. Additional factors include: increased mobility options for the elderly, disabled, and youth populations, people being willing to live farther from their jobs, and increased road capacity due to shorter headways between vehicles and reduced parking requirements.
- Infrastructure. Depending on the evolution of driverless vehicles (and connected vehicle technology as well), local infrastructure will need to keep pace. Specifically, local governments may need to update and reconfigure signage, speed limits, signal timing, roadways and parking spaces.
- Transit. As driverless vehicles become more popular, everything from service coverage to vehicle types to labor requirements stands to change. Transit agencies will need to completely re-think their services, labor needs, and fee structure in order to stay competitive in the new transportation environment.
- Financials. The widespread use of driverless vehicles will have potentially significant financial consequences for local governments. Taxes, parking fees, speeding tickets, parking real estate, and incident management costs are just a few of the government revenues and costs likely to be impacted. Moreover, the local government may need to identify new sources of revenue to pay for infrastructure (similar to today). Local governments should understand the impact of driverless vehicles ahead of time and prepare accordingly.

The following section describes specific actions the state, regional, and local governments can take both now and in the future to proactively address the issues likely to arise from the proliferation of driverless vehicles in our society.

3.0 Local, Regional, and State Government Recommendations for Action

Driverless vehicles will have significant impacts on many aspects of society, and, as such, local, regional, and state governments need to start planning for these now. In fact, local governments need to consider the following planning and policy actions now and in the next decade, especially since the AV roll-out is well within transportation planning time horizons:

- Near-Term Planning Activities
- Medium- to Long-Term Activities, including planning, infrastructure modifications
- Policy Activities

While short-term planning activities need not be time or labor-intensive, the policy activities and medium- to long-term recommendations will likely require significantly more resources and political will. This is described in more detail in this section.

3.1 Near-Term Planning Activities

The next few years will likely be a time for continued development and testing of the driverless technology. The recommendations outlined for the near-term are focused on supporting the advancement of the technology and positioning the government to successfully plan for the future driverless vehicle society.

3.1.1 Stay Educated on Driverless Vehicle Progress

It is vital that local, regional and state governments become educated on the state of this constantly-evolving industry. Government representatives should follow driverless vehicle developments – both in technology advancement and national policy development internationally. While many aspects of the technology are being developed confidentially, there is plenty of publicly-available information to learn from. These are a few approaches to monitoring these developments:

- Subscribe to ITS America Smartbrief and attend local and national ITS conferences
- Follow the Transportation Research Board (TRB) Vehicle Highway Automation Committee
- Subscribe to the Association for Unmanned Vehicle System's International (AUVSI's) listserv and attend their conferences
- Set up a weekly news alert for "Driverless vehicles" and "driverless cars"
- Follow blogs for emerging developments in driverless vehicles, such as Driving towards Driverless and Driverless Car Market Watch.

Other reports and websites can be found in the Additional Resources section found at the end of this Guide.

3.1.2 Incorporate Driverless Vehicles into City Goals

Driverless vehicles present an opportunity for state and local governments to meet many of their goals. Many cities are undertaking Vision Zero initiatives, setting greenhouse gas reduction goals, increasing transit cost-effectiveness goals, and aiming to enhance freight mobility. Government agencies may consider evaluating how AVs could directly impact long-range goals, such as these. This USDOT report provides an approach for estimating the potential benefits associated with automated vehicles.

3.1.3 Establish Communications and/or Coalition with Driverless Vehicle Stakeholders

Ideally, government entities will become partners with this ever-growing community. Stakeholders to consider can include local representatives from automobile manufacturers, driverless technology developers, insurance providers, and academic institutions. Participation in a coalition can be a way to garner or provide valuable input as policies and plans are developed in future years.

3.1.4 Support Testing Activities

States will likely continue to be responsible for driverless vehicles' licensing and testing requirements in order to ensure public safety. This includes establishing the standard for who can "drive" (or be responsible for) a driverless vehicle, and how and where it must be tested. This guide does not have any specific recommendations for these requirements; however, consistency between states and collaboration with the technology developers is highly encouraged.

Additionally, government entities may consider offering government-owned closed-campus land parcels as locations for technology developers' testing. Examples include: college campuses (e.g., Santa Clara University), islands, and former military bases (e.g., GoMentum). This can support the advancement of the technology while also keeping government informed and connected to its private industry partners.

3.1.5 Establish Policies and Plans with Consideration for the Future

In addition to increasing awareness around driverless vehicle technology, local, regional and state governments should develop current plans and policies with an eye to the future and a focus on safety. The ability to create plans and policies that are flexible and easily updated will be vital as technologies evolve and society's needs change. For example, a transit agency's fleet management plan may specify vehicle needs for the next 30 years; however, it should also acknowledge the potential for a significant change in vehicle technologies and vehicle sizes. Additionally, plans for expanding roadways and parking may end up being unnecessary. This acknowledgement will be important to factor into the agency's planning functions and vehicle procurement strategy.

3.1.6 Encourage Open Data Sharing

As more information becomes available, the government is in a position to encourage the open sharing of data. While it is important to preserve people's privacy, open, anonymized data can improve government decision-making and help the government to develop more informed policies and plans. Information on what open data is and why it's important can be found here.

Data philanthropy, or the willingness of private companies to share their data, may not happen. In order to motivate these private companies, government may consider giving companies strong tax incentives for sharing data for public good. Additionally, public and private companies will need to work together to identify models for data sharing in ways that respect personal privacy and security and enable companies to do well by doing good.

3.2 Medium to Long-Term Recommendations

The following recommendations present activities that will likely need to happen no matter how or when driverless cars are introduced into society. These include planning activities, infrastructure modifications, and a few additional miscellaneous activities.

3.2.1 Planning Activities

The following activities represent short and long-range planning considerations that will continue to evolve over the next few decades. It will be important to re-evaluate all of these activities as driverless vehicles become more pervasive in society.

1. *Update travel demand model*

As more information around driverless vehicles and their usage becomes available, travel demand models will need to be updated. The travel demand models should ideally reflect updated information regarding who is traveling (e.g., elderly and disabled may travel more due to AVs), where people are living and working, how many trips they are taking, people's value of time while traveling, what level of shared rides are occurring, and the vehicle ownership model. It should also capture any changes associated with freight delivery. All of these factors are likely to impact travel behavior. Modeling these impacts will likely be refined as the technology is developed further; however, this research paper describes one approach to updating an existing activity-based travel model.

2. *Evaluate Road Capacity Needs*

Based on findings from the travel demand model, update long-range plans to reflect whether driverless vehicles will result in increased or decreased congestion, and develop strategies to address increased congestion if warranted. Road congestion may increase or decrease depending on whether or not VMT increases or decreases and whether or not vehicle throughput is increased.

3. *Assess transit service delivery plans and fleet requirements*

Transit agencies should seek to leverage driverless technology to maximize the cost-effectiveness of their service while ensuring equitable, fairly-priced mobility options for everyone. As such, they will need to evaluate the full mobility eco-system (especially how it has evolved in recent years with many private companies getting involved) to determine the appropriate level and location of transit services. Transit agencies may consider the following:

- Leverage private mobility companies to provide first/last mile solutions to longer-distance transit services
- Transition the transit fleet to leverage driverless technology – potentially beginning with bus rapid transit and other services operating in protected guideways
- Transition or subsidize paratransit services to private mobility companies

Transit agencies will also need to re-evaluate its fleet management plan in order to incorporate driverless vehicles in its fleet. This will have significant implications for labor requirements (and Union agreements), maintenance facilities, maintenance workers, safety and security of passengers, etc.

Note: This applies to public school bus systems as well.

4. *Forecast financial implications*

Utilizing a cross-functional group of stakeholders, government officials should examine every line item of the budget to evaluate the potential financial implications of driverless vehicles. Examples of line items to consider are:

- Parking revenues (or alternate revenues associated with land previously used for parking)
- Speed ticket violation fees
- Tax revenues related to vehicle purchases, registration fees, and VMT
- Health and life insurance costs

- Transit agency costs and revenues
- Incident management costs
- Insurance costs
- Government fleet transition to driverless vehicles
- New enforcement activities
- Unemployment insurance

Note: Driverless vehicles may provide opportunities for municipal services to be delivered more cost-effectively as well.

3.2.2 Infrastructure Modifications

The following activities highlight the many infrastructure changes likely necessary over the next couple of decades. Many of these details will not be determined until the driverless vehicle technology is more fully developed and, in some cases, until these vehicles are prevalent in society; however, some may be necessary prerequisites for the AVs to be able to drive efficiently and safely.

1. *Update traffic signs and markings*

Local governments should monitor and provide feedback on any updates to the Manual on Uniform Traffic Control Devices (MUTCD) and local versions of the manual. This will provide information regarding changes to standards regarding how traffic signs, road surface markings, and signals are designed, installed, and used.

2. *Reduce lane width*

Assuming lanes are marked appropriately, driverless vehicles will not require the traditional 10-12 foot lane widths on local roads or highways. This may not be a necessity, but the reduction could increase the capacity of roadways, provide added space for bike lanes, and/or improve walk-ability.

3. *Alter speed limits*

Driverless vehicles will travel at or below the speed limit specified on roads. In a fully driverless vehicle society, it may be just as safe to have higher speed limits in some contexts, especially on highways, and speed limits in urban areas could also be adjusted to maximize safety benefits. It is likely that the methods for setting speed limits will change over time. Federal guidance regarding speed management safety can be found here.

4. *Adjust traffic signal locations and timing*

A fully driverless vehicle society will likely introduce entirely new travel patterns. As a result, the local government may need to alter the traffic signal locations and timing. In the future, traffic signals may be unnecessary or they may be highly adaptive to current traffic flow.[2] Additionally, local governments may consider prioritizing pedestrians, cyclists, transit, and shared occupancy vehicles at intersections.

5. *Eliminate/Reduce parking and add more drop-off/pick-up locations*

Many parking spots (both on and off-street) may be unnecessary due to the potential for lower private vehicle ownership and the ability of driverless vehicles to park themselves in remote locations. On the other hand, they may still be necessary, but they could be re-located (potentially outside of city centers).

[2] Note: This introduces new concerns regarding pedestrian and biker safety.

For these reasons, more infrastructure for passenger pick-up and drop-off locations may be required. Additionally, parking space sizes may be reduced.

6. *Add electric vehicle charging infrastructure*

Most forecasts and studies assume that driverless vehicles will utilize electric-powered vehicles. This technology is still evolving; however, it is likely that public infrastructure, including parking spaces and pick-up/drop-off locations could better support mobility by providing electric charging stations. Moreover, "dynamic wireless power transfer" technology may provide mobile charging to vehicles via roadways while in motion[3]. The United States Department of Energy's website has useful information about this technology.

7. *Develop new predictive models for pavement maintenance*

The timing for pavement maintenance may be quite different from today's requirements. Level of roadway usage may significantly increase or decrease (depending on whether or not VMT increases or decreases) and driverless vehicles may be lighter and operate in a way that has less impact on the roadway.

8. *Designate/certify roads for driverless and/or manual operation*

Designating or certifying roads implies that the roadway owner (a government entity) would provide some framework for evaluating and confirming a roadway is acceptable for a specified usage. It is debatable whether or not this will be needed. Some see this as inevitable since roadway owners will assume some level of responsibility for the "driving public." On the other hand, others think certifying roadways (whether for driverless or manual cars) would be too resource-intensive and would also imply a higher level of liability than is appropriate. That being said, examples of certification requirements may include clear markings for the vehicles to read, markings, or signage to designate the road as certified, electronic communications/updates regarding speed limits, and appropriate signage regarding construction zones, and communications to other road users about the vehicle types allowed on that roadway.

3.2.3 Miscellaneous

The following activities do not fit into any of the previous categories. They include updating the local government's enforcement and incident management functions.

1. *Update enforcement function within government*

Existing enforcement activities, including the pursuit of speed limit evaders and drunk drivers, will likely be completely unnecessary in a driverless vehicle society. In fact, the enforcement requirements will likely shift to include the following types of activities:

- Certifying roadways and ensuring driverless vehicles are driving safely on these roadways
- Ensuring safety and payment of transit passengers
- Ensuring any managed roadways (Express Lanes, HOT lanes, etc) are collecting appropriate revenues
- Ensuring data is shared appropriately

[3] http://www.citylab.com/commute/2015/08/the-uk-is-testing-roads-that-recharge-your-electric-car-as-you-drive/401276/, November 20, 2015

2. *Update incident management function within government*

Currently, the government spends a significant amount on responding to car accidents and even addressing roadkill. While some level of car accidents will be inevitable, the number of incidents is forecasted to decrease substantially. As such, the local government can reduce that function and potentially reduce costs.

3. *Incorporate driverless vehicle technology into government services*

The government provides many services and conducts many activities that involve vehicles without passengers. They are potentially early opportunities for the government to consider both testing and incorporating driverless technology into their business practices. Examples may include street cleaning and parking enforcement.

4. *Update government workforce to match needs*

There is no question that the government's role will need to change. As such, it will be necessary for governments at all levels to ensure that its workforce has the skill sets needed to fill different positions and functions that emerge as people change their travel behaviors and patterns. While this is hard to predict at this point, it will be important to follow driverless technology developments around the world and invest in training throughout this time of significant change. In the short-term, governments should consider hiring people who can actively support the many changes likely to occur in the government during this time.

3.3 Policy Activities

Driverless vehicles have the potential to greatly increase or decrease VMT depending on the level of ride sharing and vehicle sharing that occurs. The following activities represent policies that the government can put in place to influence how driverless vehicles can affect VMT, urban sprawl, and/or parking requirements. These policies can be put in place at any time; however, the sooner they are in place, the sooner any potential negative impacts of driverless vehicles can be mitigated.

3.3.1 Update roadway policies and infrastructure to manage the VMT impact

Unless a ridesharing model prevails, driverless vehicles present the risk of people increasing the amount that they travel significantly. With the propagation of electric vehicles, the cost of fuel likely decreasing, and the ability to be productive while in their car, people may travel more often and for longer distances. For that reason, the following changes to the roadways may help to disincentivize this potential increase in VMT by encouraging shared mobility models:

- Adopt or increase roadway tolls in general and/or specifically for single occupancy vehicles
- Add or designate more high occupancy vehicle ("HOV"), high occupancy toll ("HOT"), and express lanes
- Add congestion pricing in and around urban areas or downtown cores/central business districts
- Develop policies for managing the likely need for more curb space for pickups/drop-offs, and provide priority access for high occupancy vehicles.

3.3.2 Adjust land use polices to reduce urban sprawl

Driverless vehicles present the risk of people being willing to live much farther away from their workplaces since their commute times may be newly productive. For that reason, it will be important for local governments to establish policies that encourage high density, walkable communities in order to minimize urban sprawl. Examples include:

- Add more transit-oriented development and transit service, in order to allow better hubs for driverless vehicle pickup and navigation
- Maximize areas within walking distance of each other by minimizing space allocated to parking
- Create policies and processes that encourage developers to build walkable communities
- Create and enforce urban growth boundaries
- Develop policies that make greenfield development and septic-based development very expensive and onerous while, similarly, support infill development
- Improve the quality of the schools in the urban core

3.3.3 Adjust the tax/fee structure to dis-incentivize car ownership and/or parking

Driverless vehicles may result in an increase in single occupancy vehicle trips (and, ultimately, increased VMT). Taxes and fees can be increased or decreased to incentivize sharing rides and dis-incentivizing private car ownership and single-occupancy vehicle rides. Examples of taxes that can do this include[4]:

- Sales tax or vehicle license fee on private vehicle purchases
- Tax on vehicles miles travelled
- High fees for public parking and high taxes for private parking
- Reduced (or even subsidized) costs and parking fees for shared ride services
- Reduced (or even subsidized) costs for bike share, shuttles, and other first/last mile solutions
- Leverage driverless vehicle services for local "guaranteed ride home" programs so commuters feel confident they can get home irrespective of how they got to work

3.3.4 Alter parking policies to reduce the need for private parking

If consumers own their own driverless vehicles and rarely share them, the parking needs will probably remain similar to today or will increase commensurate with the population. On the other hand, increased ride and vehicle sharing could significantly reduce or alter the parking requirements. Parking policies can be established to minimize the land dedicated to parking and manage where parking spaces are located. Examples include:

- Eliminate minimum parking requirements in zoning laws and encourage more pick-up/drop-off locations at developments
- Establish that developers pay for the right to develop parking spaces and the government can use that funding to pay for parking in designated (and possibly remote) locations
- Establish a city-wide parking space cap
- Dedicate parking spaces for shared vehicles.
- Institute variable priced parking to proactively manage how parking spaces are used.
- Establish policies requiring all new parking facilities to be designed and built to be adaptable (since it may not be needed for parking in the future). Key elements of adaptability are flat floors, comfortable floor-to-ceiling heights, and enough loading capacity to support another structural use[5].

[4] http://www.shareable.net/blog/policies-for-shareable-cities-transportation, August 3, 2015
[5] http://www.citylab.com/design/2013/11/its-time-design-parking-garages-car-less-future/7583/, November 20, 2015

Other examples of parking management policies can be found here.

3.3.5 Change transit pricing

As described earlier in this section, transit agencies will need to determine the appropriate level and location of transit service. For example, smaller vehicles with dynamic service may make public transit competitive with private vehicles and other mobility providers. In conjunction with this planning effort, it will be important to evaluate transit's "competition" and ensure the transit service is competitively priced and comparable in reliability, convenience, and safety. Transit has always been subsidized and this will likely need to continue – especially if it is intended to support the low income population and potentially low ridership routes. Without the significant labor costs including salaries, benefits, and pensions, there is a real opportunity for transit agencies to become more competitive and financially-sound through the use of driverless vehicles.

4.0 Conclusion

Driverless vehicles are coming, with or without government involvement, and there is no question that they will have a significant impact on society. People may choose to live farther from their jobs, roads may become even more congested, and public transportation may no longer exist. On the other hand, road safety may be drastically improved and current non-drivers may have new mobility options. The driverless vehicle could, literally, change how we approach all aspects of life.

Simultaneously, the lines between public and private responsibilities with regards to mobility are blurring. Automakers are becoming service providers, the taxi business model is becoming obsolete, and ride-hailing companies are providing new mobility options. This has created new "competition" for public transit and, as such, is requiring the government to re-think its role in mobility. These changing perspectives towards various transportation sectors, combined with the potential of driverless vehicles to transform all of these sectors, creates a huge opportunity for local, regional, state, and federal governments to use driverless vehicles to meet their transportation, land use, and mobility goals.

With the coming of driverless vehicles, the governments (at all levels) have the opportunity to proactively establish goals and policies that can continue to support the driverless vehicle revolution while keeping the traveling public safe and mobile.