DRIVING THE REGION’S FUTURE
AUTONOMOUS VEHICLE TECHNOLOGY & ITS IMPLICATIONS FOR NORTHERN VIRGINIA

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Local Governments Need to Rethink their Design, Strategy, Operations & Processes in Fundamental Ways

Without doing so, local governments cease to remain relevant.
INTRODUCTION

Epoch change creates great risks and great opportunities. Now as the nation enters a new chapter in the automotive era, an era which has shaped cities and counties across the nation, everything is about to change. Even as the Washington, D.C. metropolitan region begins to grapple with the SafeTrack initiative to address both the inadequate maintenance of its rail system and the Congressional failure to address the nation’s transportation infrastructure, the region, and the country, are headed towards one of the greatest economic and technological revolutions since Henry Ford created the moving assembly line a century ago.

Cities, counties, and states are connected by vast swaths of highways and streets, and nearly 40 percent of land area is devoted to parking accommodations for over 255 million vehicles. These autos force state legislators to contemplate high level issues, such as taxes, transportation, regulation and enforcement, and capital budgets. At the local level, elected leaders must grapple with zoning, land use, regulation and enforcement, and even respond to the mean and ornery challenges of potholes and snow and ice removal. In the Washington, D.C. metropolitan region, where chambers of commerce strongly opposed the construction of Metro decades ago, some inspired local leaders serving Arlington, Alexandria, and Fairfax County through the Council of Governments, were vital to the construction of a system which reshaped the region. One such leader, former Virginia State Senator Mary Margaret Whipple, was perhaps the most visionary: she understood how innovative land use and zoning for Metro could create an economic juggernaut in Arlington County, and significantly reduce traffic and air pollution in the community.

Now we have arrived at the intersection of technology, the internet, and self-driving cars. In a nation where passenger vehicles have outnumbered licensed drivers since 1972, and where New York City is the only municipality in the country where more than half of all households do not own a car, the region, and the nation, are driving toward a post-Uber era of on-demand mobility and data-driven services. Through the accelerated rise of new technologies, sustainability policies, changing consumer preferences around ownership, increasing automation, and new business models, the automotive sector will see four disruptive trends: diverse mobility, autonomous driving, electrification, and connectivity. These transformations could create up to $1.5 trillion or 30 percent more revenue potential by 2030.

This transportation revolution reshaping the region’s future comes in the midst of a parallel change: demography. The Washington region is most comparable to Silicon Valley in terms of having a creative class made up of diverse entrepreneurs from an extraordinary range of backgrounds. The area boasts an abundance of higher learning institutions and organizations. For example, the Defense Advanced Research Projects Agency (DARPA) has provided impetus for technological advances by organizing the Grand Challenges for developers of self-driving vehicles.

Demography is also changing in ways important to mobility: citizens are aging. Medical technology and improved access to healthcare mean longer lifespans and a growing cohort no longer able to drive to the doctor, pharmacy, or grocery store. Technology, like self-driving cars, will be vital to the quality of their lives, especially at a time when family generations are less likely to live in the same community. Why does it matter to policymakers? For the region’s elected leaders, these changes pit risk against opportunity. How can elected leaders steer their governments and communities through these unprecedented challenges? How can local leaders fulfill their role in charting the future? Good governance, after all, is not self-driving.
Northern Virginia is a region within the Washington, D.C. metropolitan area located in the northeastern part of the state. The region is comprised of nine jurisdictions, consisting of four counties and five independent cities. The region spans 1,337.2 square miles, amassing just over three percent of Virginia’s land area, and accounts for nearly 30 percent of the state’s total population.

Within the last decade, Northern Virginia has experienced an average population increase of 19.3 percent, whereas Virginia and the country, as a whole, have seen an increase of just less than five percent. In the coming years, the University of Virginia’s Weldon Cooper Center for Public Service projects that the outer rings of the region will continue to grow at a rapid pace, 26.4 percent, while the easternmost jurisdictions will grow at a much slower rate, approximately ten percent of the region’s population is 65 years of age or older, a proportion that will only grow in the coming years. Local leaders need to approach self-driving technology with the mindset of capitalizing on autonomous vehicles and their ability to enhance the delivery of public services for these subsets of the population.

Nearly 24 percent of Northern Virginia’s population is 18 years of age or younger, a large subset of which is under the age of five. This segment of the population represents the region’s future stakeholders, poised to consider self-driving technology as more people will inhabit roadways and utilize public transportation.

There is over 17,000 lane miles of roads and more than 1.8 million licensed drivers in the Northern Virginia region. Every year, more than 30,000 crashes occur among these individuals, most of which are the direct result of human error. These numbers have increased considerably each year as the region’s population continued to grow and more drivers navigate local roadways.
I. DEFINING AUTONOMOUS VEHICLES FOR THE PUBLIC

Our transportation system is evolving rapidly. Smartphones have given individuals access to more services than ever before. There is an app for everything, including transportation, with services like Uber and Lyft. As we travel into the future, autonomous vehicles appear to be the next greatest technological transportation resource. For those who can recall a time before the Internet and cellphones, society functioned much differently on a day-to-day basis. Similarly, autonomous vehicles are expected to leave a lasting imprint.

As autonomous vehicles are introduced to the general public, local governments will need to be proactive in educating the community about this technology. This includes defining the different types of automated vehicles, as well as the requirements for either operating or riding in these vehicles. The U.S. Department of Transportation’s National Highway Traffic Safety Administration (NHTSA) defines autonomous vehicles as self-driving vehicles where “operation of the vehicle occurs without direct driver input to control the steering, acceleration, and braking, and are designed so that the driver is not expected to constantly monitor the roadway while operating in self-driving mode.”

### LEVELS OF AUTONOMOUS VEHICLES

<table>
<thead>
<tr>
<th>LEVEL</th>
<th>Description</th>
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<tbody>
<tr>
<td><strong>LEVEL 0</strong></td>
<td>No Automation</td>
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<tr>
<td><strong>LEVEL 1</strong></td>
<td>Function-Specific Automation</td>
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<tr>
<td><strong>LEVEL 2</strong></td>
<td>Combined Function Automation</td>
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<tr>
<td><strong>LEVEL 3</strong></td>
<td>Limited Self-Driving Automation</td>
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<tr>
<td><strong>LEVEL 4</strong></td>
<td>Full Self-Driving Automation</td>
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*Driver is in complete and sole control of the vehicle.*

*Automation involves one or more specific control functions. Examples include electronic stability control or pre-charge brakes where the vehicle automatically assists with braking to enable the driver to regain control of the vehicle or stop faster than possible by acting alone.*

*Automation of at least two primary control functions designed to work in unison to relieve the driver of control of those functions. An example is adaptive cruise control in combination with lane centering.*

*Automation enables the driver to cede full control of all safety-critical functions under certain traffic or environmental conditions, and in those conditions to rely heavily on the vehicle to monitor for changes in those conditions requiring transition back to driver control.*

*Vehicle is designed to perform all safety-critical driving functions and monitor roadway conditions for an entire trip. 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.*

Source: National Highway Traffic Safety Administration

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SECTION ONE

SOCIAL IMPACTS

Local governments play a key role in how information is organized, disseminated, and utilized by residents.
II. EDUCATING THE COMMUNITY

Educing the community about new technology is essential. Citizens will be curious about what autonomous vehicles are and how this technology can improve and advance society. First, the technology itself needs to be defined. Second, the community needs to be educated about how this technology can benefit individuals, families, and the environment. Local governments will play a key role in how information is organized, disseminated, and utilized by residents.

Strategies for Citizen Education

Standards and regulations will play important roles with automated vehicle technology. NHTSA is the primary federal regulator of safety and typically enacts Federal Motor Vehicle Safety Standards (FMVSS) that specify performance standards for a wide range of safety components, including specific crash test performance. Although NHTSA can issue recalls and influence the marketplace, it has no jurisdiction over the operation of cars, actions of vehicle owners, maintenance, repair, or modifications vehicle owners may make. Essentially, voluntary vehicle maintenance standards will be critical components to standardizing safety. Citizens will need to be educated on maintaining personal automated vehicles, and companies with fleets of automated vehicles will need to sustain maintenance standards.

Governments should identify “point people” at both the state and local levels. These individuals will coordinate with various political actors, and federal, state and local authorities to educate their constituents on the needs for development, demonstration, and deployment of this technology.

Government actors need to advance their understanding of this technology and its implications for state and local authorities. Coordination and communication through interagency teams is needed. These teams should include specialists in transportation, transit, parking, law enforcement, education, environmental protection, health and human services, commerce, workforce development, land use, zoning, planning, and others.

Strategies for Engaging the Community

Government officials need to identify public and private networks of support. These networks should include targeted modes of collaboration between executive offices of the state, the Department of Motor Vehicles (DMV), and local interagency government teams. A successful support network should focus on accountability among all actors. For instance, a successful network would ensure that local DMVs stay current on relevant regulatory information.

Government officials should develop websites to engage and inform citizens about this emerging technology. This will help manage public expectations about how to utilize the technology. In addition, government officials should also develop websites to engage the business community. Targeted audiences include developers, insurers, advocacy organizations, buyers, partners, and users. Developing websites for both of these groups demonstrates government’s commitment to ensuring the successful utilization of autonomous driving technology and ensures that society can contribute and benefit from the availability of these resources.

The community should be educated on the potential for cost savings. One particular example is car-sharing programs. By focusing on car-sharing programs, individuals could pivot from the annual fixed costs associated with traditional auto ownership, such as capital depreciation, finance charges, vehicle registration fees, and insurance. A 2016 report from the Rand Corporation suggests that car-sharing programs could save households an average of $6,000 a year.

Since the emergence of autonomous vehicle technology is still new, government officials can conduct pilot tests in structured environments. In doing so, public officials can run controlled simulations to gain a better understanding of opportunities and challenges for their communities. Ideal areas for testing include bus-dependent suburbs, real-estate developments, retirement communities, universities, hospitals, airports, amusement parks, and military bases.

Lastly, government officials should introduce autonomous vehicles to different socioeconomic groups in order to make driverless vehicles an option across the economic spectrum. Development of special automated vehicle stops, such as bus stops or routes near local government resource buildings, could be developed to improve accessibility. Level four vehicles could be utilized to increase access and mobility across a range of populations for those who are unable to travel in or use conventional automobiles. This population may include the disabled, older citizens, and children under the age of 16. This will help instill personal independence, reduce social isolation, and improve access to essential services.

III. LEGAL STRATEGIES FOR GOVERNMENT

A number of states have passed laws to regulate the use of autonomous vehicles. Governments will need to explore these laws, as well as many others that have been proposed. State and federal policymakers need to understand the effects of existing policy, or lack of policy, and the impact of the adoption of this technology. One specific example pertains to the development of a legal distinction between what constitutes a passenger and driver.

Historically, DMVs have been responsible for testing and issuing drivers’ licenses, while federal bodies, like NHTSA, regulate the safety of vehicles. Autonomous vehicles, however, blur the line between vehicle and driver. DMVs will need to change many of the requirements for issuing licenses for these vehicles. A new training program will need to be developed to educate drivers and passengers in these vehicles. Additionally, testing changes will also be needed prior to operating different types of automated vehicles.

Autonomous vehicles may present conflicts with states’ current distracted driving laws and regulations, especially with respect to navigation systems. State lawmakers will need to consider updating these laws to accommodate the use of autonomous vehicle technologies. Speeding laws, distracted driving laws and intoxicated driving laws may be modified by the utilization of automated vehicles. The National Transportation Safety Board suggests standardizing these technologies to help governments streamline driving laws and achieve safety goals.

Anticipating and testing operation in all environments is challenging and poses significant barriers to deploying automated vehicles. Assuming that there will be unforeseen obstacles, governments need to consider controlling the environment for automated vehicles with the development of special restricted lanes for operation.
IV. SAFETY IMPLICATIONS

Vehicle accidents kill approximately 33,000 Americans and 1.2 million people globally each year. According to the Center for Disease Control and Prevention, motor vehicle accidents are a leading cause of premature death in the U.S. and account for $80 billion annually in medical care and lost productivity due to injuries. In the Northern Virginia region, 30,309 accidents occurred in 2015, resulting in 15,498 injuries and 80 deaths.

Autonomous vehicles are expected to reduce hundreds of deaths per year. According to the NHTSA, over 90 percent of crashes are caused by human error. Driver related alcohol or drug use, driver distraction, and fatigue are responsible for 53.5 percent of fatal crashes. In the Northern Virginia region, 1,660 alcohol-related accidents occurred in 2015, resulting in 966 injuries and 17 deaths. When compared to the number of crash-related deaths, alcohol accounts for 21.3 percent of fatalities. Autonomous vehicles are never drunk, distracted, or tired.

Estimates project that autonomous vehicles will reduce crash and injury statistics by 50 percent, as well as reduce legal violations, such as speeding or red light infractions. It is anticipated that motorcycle accidents could be reduced by 25 percent. Autonomous vehicles powered by software, cartography sensors, and computers, can analyze real-time models of the world around them and respond appropriately. Human drivers, however, become angry, tired, and distracted, which can reduce reaction times. If widely deployed, autonomous vehicles will not only improve safety for passengers in the vehicle, but will also improve safety for bicyclists, motorcyclists, and pedestrians.

Google’s self-driving cars have been in 17 crashes since 2009, mostly fender-benders. In every case but one, the company maintains that a human was at fault. Dmitri Dolgov, head of software for Google’s Self-Driving Car Project, says that one thing he has learned from the project is that human drivers need to be “less idiotic.” According to Google, their autonomous vehicles are more courteous, and more defensive than normal drivers.

Unsupervised children in autonomous vehicles presents some concerns about safety. Although technology continues to advance, human nature remains constant. Despite this advancement in technology, an adult may still be needed to supervise children when en route to school or other activities. Secondly, governments may want to consider requiring background checks on those individuals supervising children under the age of 18 in autonomous vehicles who are not their parents or custodians. Despite concerns, the benefits of self-driving cars outweigh the risks. The likely reduction in car accidents due to human error will make self-driving cars more secure than current modes of transit.

Source: National Conference of State Legislatures

<table>
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<tr>
<th>State</th>
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<th>State</th>
<th>Bill Number</th>
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Source: Virginia Highway Safety Office
Several states have taken legislative action to address autonomous vehicles. Washington, D.C., Nevada, California, Florida, and Michigan permit autonomous vehicles within their state or district for testing purposes. As the NHTSA recommends, these states are providing rules on who can operate these vehicles.

A debate still remains on whether an operator can be under the age of 16 years old, since the operation is automated. California’s law requires that a person defined as an “operator” must be in the vehicle and ready to take over should the autonomous technology disengage. Current best practices assume that an operator will have a valid driver’s license during this testing period. After the launch, policymakers still need to determine if automated vehicles will need licensed drivers. Given the size of California and its early lead in developing policy, it presumably will serve as a model for other states. The California DMV develops the regulations on testing automated vehicles, as opposed to a transportation or safety agency. The California DMV has collaborated with other agencies, and has incorporated civic engagement by holding workshops with manufactures, academics, and public advocates.  

V. LIABILITY QUESTIONS

A self-driving vehicle does not completely eliminate the risk of an accident. In fact, there is no legal precedent for how such a case would be handled. Who holds responsibility in a vehicle accident: the driver, the vehicle manufacturer or the software developer? If vehicles are in full autopilot, it seems counterintuitive to argue that the driver would be at fault. In crashes where drivers are reasonably relying on a vehicle’s ability to control itself, an at-fault driver scenario is more likely. The shift in responsibility from the driver to manufacturer may make no-fault auto insurance regimes more attractive. The victim presumably may sue the vehicle manufacturer.  

Auto insurance and auto accident lawsuits are a multi-billion-dollar business. Eliminating drivers and the accidents drivers cause would unsettle this vast business enterprise. A shift in driver responsibility will likely downsize car insurance companies and redirect lawsuits.

Ben Schiller from Fast Company writes about how autonomous vehicles will disrupt the car insurance industry. He quotes Warren Buffet: “The truth is, it’s a safer way of driving; it’s good for society; and it’s bad for our insurance business.” When asked about the potential effect of autonomous vehicles on his GEICO subsidiary, Buffet responded, “Anything that cuts accidents by 30 percent, 40 percent, 50 percent would be wonderful, but we would not be holding a party at our insurance company.” This is because driverless vehicles are expected to prevent 90 percent of accidents.

VI. IMPACT ON THE FAMILY

Accessibility of the internet and cell phones have enabled society to be connected, whether at home, work, or play. How will the introduction of autonomous vehicles in society impact the family system? For the purposes of this guide, the family system is defined as the interactions, patterns and interdependence that exists between family members and the values family’s share.

Vehicles have become an extension of home and work that solidify social relationships due to the amount of time spent traveling. Communication among parents, children, friends, and significant others is encouraged by the “captivity audience” aspect of car travel. A certain intimacy is established within vehicles when humans interact. Uninterrupted time spent together allows families to organize and communicate. It is assumed that autonomous vehicles will improve relationships due to the limitation of distractions.

The implementation of autonomous vehicles in society will have a “revolutionizing impact on family life.” People will travel further and faster due to fewer traffic jams. This will decrease anxiety and stress which may potentially reduce the risk of cancer. Using autonomous vehicles will allow people to sleep, work, and relax during their commute, which will provide them with more time and energy for their family when they arrive home. Parents will no longer have to leave work early, or rush to pick up their children from school to transport them to activities. A family-owned vehicle could be utilized by all members of the family independent of one another.
While the vehicle is doing the driving, family and friends will be involved in various activities such as cooking, movies, playing games, taking online classes, and other activities. This may result in families traveling further distances for both work and pleasure, since they will not have to be tied to a desk or kitchen table to perform tasks that can be done in the car.

Community Health and Wellness

Autonomous vehicles are expected to have various health implications. First, a reduction in deaths should decrease the number of available organ donations. Therefore, advances in biomaterial research, such as 3D printing, will be critical to sustaining this need. Secondly, autonomous vehicles are expected to reduce premature births.

According to the Bureau of Transportation Statistics, human factors, such as driving under the influence and other means of distracted driving and fatigue, are the most common cause of vehicular accidents. In 2012, alcohol impaired driving contributed to 18 percent of fatal crashes involving drivers between the ages of 16 to 20. These same statistics also indicate that alcohol was involved in 48 percent of all fatal pedestrian crashes.

According to Sparks and Honey, it is expected that alcohol and drug use and sales will increase due to increased consumption in the privacy of the vehicle. However, because there will not be an identified driver, it is expected that DUI citations will decrease. This will result in a loss of income for local governments, and could give rise to increased rates of addiction.

VII. SOCIAL JUSTICE

There are approximately 6.6 million legally blind adults in the United States, and 50 million adults living with epilepsy worldwide who rely on public transportation or assistance from others to get around. The American Disabilities Act of 1990 defines a disability as "any physical or mental impairment that substantially limits one or more major life activities of the individual." The DOT’s Americans with Disabilities Act requires accessible and timely transportation to be provided for passengers with disabilities. Public transportation is known to be constantly riddled with issues due to infrastructure breakdown. Relying on others for transportation can become burdensome for both parties.

According to Paul Stengquist of The New York Times, autonomous vehicles “could prove to be a life-changing breakthrough for many people with disabilities, granting them a new measure of independence.” The technology will enhance independence, reduce social isolation, and enable transportation to various service providers. Across the nation, public agencies allocate up to 18 percent of their budget to provide paratransit services to their customers. Autonomous vehicles will reduce the need for funding for paratransit services while increasing societal benefits. Individuals who require 24-hour supervision will still require an aide to support them during their trips. For example, self-driving taxis will be unsuited for passengers with disabilities who need assistance getting in and out of vehicles or with luggage. Aides will have to assist these individuals with their trips.

With the implementation of autonomous transportation, it will be necessary to address social inclusion through policies and legislation. There is a clear link between effective transportation and social inclusion. Transportation enables individuals to further their education and enhance their professional skills, training opportunities, and socioeconomic standing. Autonomous vehicles will provide accessibility to a wide range of services such as healthcare, shopping, recreation, and religious pursuits. Without transportation, households are at risk for social exclusion. This can create “deprived neighborhoods, family breakdown, poor core public services and public service failure.” Local governments must create a link between lower socioeconomic neighborhoods and local and regional economies to plan for the effective utilization of self-driving vehicles.

As we travel into the next generation, self-driving cars will be a vehicle of opportunity, especially for populations, such as the elderly and people with disabilities. A transparent, community-friendly education plan needs to be accessible for all populations as autonomous vehicles are introduced. Government actors need to coordinate at the federal, state, and local levels to ensure proper safety guidelines, measure economic implications, and ensure inclusion for diverse populations. Government agencies will need to stay current as innovation promises to advance at a rapid pace.
I. HOUSING

There is little doubt that autonomous vehicles have the power to change transportation, but what is less obvious is the significant effect these vehicles have on housing. In truth, transportation and housing are intertwined elements in people’s lives. The choices an individual makes about one element has an effect on the other. The housing where one chooses to live typically define one’s transportation options. Some communities are walkable; some have ample public transportation options, such as bus and light rail; and other communities are nearly impossible to get around without a car. Conversely, the transportation one chooses to use also effects one’s housing. Car ownership not only enables people to live farther from where they work, but also requires them to access parking. The unique attributes of this emerging technology present the potential to increase housing stock and affordable housing developments.

Housing Locations

The two primary social environments for most adults are home and work. Transportation connects these two places. The advent of the automobile and the infrastructure that sprung up around it, such as highways and gas stations, enabled many people to choose housing further away from where they work. The story of the United States in the 20th century is, in many ways, a story about the automobile and its powerful effect on the social life and demographics of the population. Living in the suburbs with spacious lawns and bedrooms to spare was not only attractive to crowded city dwellers, but suddenly possible thanks to the automobile.

Suburban life, however, has its disadvantages. One of the most common complaints from citizens is the traffic-clogged daily commute to and from work. The stress of crawling along congested highways while still being required to be alert causes frustration, and even road rage. A 2012 study published in the American Journal of Preventive Medicine found that commuting distance was positively correlated with body mass index (BMI) and blood pressure.¹

The use of autonomous vehicles holds the promise of not only making the daily commute safer, but also healthier. With a self-driving vehicle, the person inside is free to sip their morning coffee, catch up on their favorite television show, and text everyone in their phonebook, without putting themselves and other commuters in danger. By removing the downsides of commuting, autonomous vehicles will likely make longer commutes possible. As a result, people will be able to rent and buy housing that is further from their places of employment where the housing is typically less expensive.
Housing Construction

One of the greatest opportunities that autonomous vehicles present, in terms of housing, is the freeing up of the region’s most limited and valuable resource: land. A 2016 study conducted by the Boston Consulting Group predicts that the combination of autonomous vehicles and ride-sharing will reduce car ownership as individuals opt for the greater convenience and lower costs of a mobility service delivered by an autonomous fleet of ride-sharing vehicles.

A reduction in car ownership will, in turn, mean less of a need for parking. Recent estimates of the number of parking spaces indicate that there may be 844 million parking spaces in the U.S., which means an average of 3.4 spaces per vehicle. Given the fact that autonomous vehicles that are shared on demand would spend less time parked, it is clear that many of these parking spaces can be repurposed. On these newly available sites, additional residential space can be constructed, tipping the supply and demand scales and increasing affordability. Another factor affecting affordability is the cost of parking spaces, which is typically passed on to renters. A 2013 Seattle study found that the cost of parking attributed to 15 percent of monthly rents.

Housing Challenges

Autonomous vehicles have a promising outlook, in terms of housing, but this future is far from guaranteed. These vehicles could have a counter-urbanization effect on society by promoting sprawl, draining resources from urban areas to the suburbs, and perhaps fostering greater segregation based on income, race, and ethnicity. Communities with an interest in reducing these negative effects must be smart and intentional in their community planning efforts if they want to promote integration, diversity, and well-functioning communities.

II. LAND USE

Enhancing Existing Planning Policy and Shaping Future Landscapes

With autonomous vehicles anticipated to hit the market by 2025, the impacts of the technology could be fully transformational to land use and the forces that influence land use policies. Additionally, regional and local planning policy should include ways the new technology may be able to assist in better implementing long-standing and widely-accepted preferred planning practices.

Smart Growth Implementation

The Smart Growth principle for localities to adopt Complete Streets policies may be supported with the rise in driverless vehicles. The Complete Streets concept is intended to encourage planners to design road systems that promote connectivity, safety, and overall mobility within communities. The anticipated changes to infrastructure could spur overhauls of long-standing policies as autonomous vehicles are integrated into the transportation system.

Design

Once communities begin to make the infrastructure changes needed to accommodate driverless vehicles, many land use opportunities will arise. Traditional suburban planning trends have been to plan for an increase in the size and scope of ever-growing infrastructure needs. Roads are planned for future widening, with arterial and collector roads also growing wider to meet anticipated development. Road design standards created with the intention to accommodate volume and meet safety standards that account for human error, such as speed limits and curves, could be reassessed. It is anticipated that roads could be redesigned to reduce lane widths, leading to a reduction in right-of-way needs. There would be little need for arterial roads to be built in suburban areas having more than two lanes. The narrowing of roads would lead to a reduction in the barrier that streets pose between land uses.

Reuse of Surplus Parking

The introduction of driverless vehicles will provide communities, both urban and suburban, the opportunity to plan for creating improved spaces. It is anticipated that urban areas will experience less vehicular clutter with the rise in popularity of driverless vehicles because the demand for parking will decrease. From a land use implementation and policy perspective, parking requirements typically stifle creativity of planners and developers and limit the ability to create developments that reflect planning best practices. Every locality in Northern Virginia has a Comprehensive Plan that includes Smart Growth Planning Principles that encourage mixed-use, pedestrian-friendly, and well-integrated development. A reduction in parking demand could mean that many of these concepts could be easily incorporated for existing and future development projects.

In some cities, up to a third of the land is devoted to parking. With a reduction in demand for parking in urban centers, the following reuses of parking areas can occur: (1) Increased streetscaping, promoting increased aesthetics and quality community design elements. (2) Increased pervious surface for stormwater infiltration leading to improved water quality. (3) Increased walkability—converted parking to biking and walking facilities. (4) Increased usable/open space, such as parks for passive and active recreation. (5) Increased mix of uses (office, residential, affordable housing, and commercial). (6) Creating autonomous vehicle zones in dense urban cores that allow specific pick-up/drop-off times, and then convert to pedestrian-only thoroughfares during other times.
Alternative Transportation
Driverless vehicles will provide a personal transit option that does not currently exist. Transit nodes are typically located where high densities already exist or are planned. In fact, the Center for Transit Oriented Development encourages regional and local planning for transit-oriented development projects to include the coordination of existing density and growth plans, transit types, housing, and jobs.12 Most suburban areas have densities that are considered low or medium density, which is far too low for localities and transit authorities to justify the cost of extending service to those areas.13 Driverless cars will effectively create a transit option within suburban and rural areas.

Infrastructure
Land use challenges for localities associated with the proliferation of driverless vehicles will center on infrastructure.15 Localities will need to amend zoning regulations to respond to the overwhelming demand for pick-up and drop-off locations within crowded urban spaces.16 In order to keep traffic in urban core areas freely moving, driverless vehicles would not be permitted to loiter in those areas. Instead, hordes of driverless vehicles would need to be removed from downtown areas while not in use.

Where will these vehicles be stored? Localities on the fringe of urban areas will likely end up being the staging area, with massive driverless vehicle depots for vehicles to park or rest while they are waiting to be summoned for service within the city. This will present land use policy and regulatory zoning challenges for communities that surround these urban centers. Nearby suburban and underdeveloped areas will bear the brunt of creating and properly locating this potentially unpleasant, but necessary land use.17 The challenge for localities is to rethink infrastructure to accommodate these necessary public facilities without sacrificing quality of life within existing communities.

The technology of driverless vehicles will expand access to transportation and increase the amount of users currently on the road. Self-driving cars will expand personal mobility for the segment of population without drivers’ licenses due to age, disability, low income, restricted drivers, or preference.18 With changes to infrastructure being slow and expensive, increased demand and accessibility to personal transportation should increase congestion on primary and secondary roadways.

Central to the concept of the sharing economy is the concept of taking advantage of existing unused assets, like empty seats in vehicles or space on roadways.19 In addition to the policy question of whose responsibility it will be to fund infrastructure improvements, the short term result is expected to be an increase in road congestion due to the anticipated popularity of these services.

Necessary Shift in Policy Focus
Lastly, there is a challenge in shifting commonly held ideals of personal transportation methods and conventional planning topics. Although driverless vehicles may be on the market as early as 2025, urban planning organizations are currently doing very little to plan for the technology and its impacts. None of the planning organizations responsible for America’s 25 biggest cities have incorporated self-driving cars into their planning development projections in any substantial way.20 This may be indicative of the reluctance of planners to propose planning policy when impacts are theoretical and sweeping in transformative. “Unfortunately, the extent and direction of self-driving cars’ impacts, particularly if transformative, are unlikely to be fully understood until they have already started to happen.”21
III. MOBILITY

Policy Choices About Privacy

One concern regarding the implementation of driverless vehicles is the issue of privacy. As vehicles gain an increasing amount of intelligence-based features, additional forms of data are generated and collected. Features currently in vehicles, such as OnStar®, generate and store information which can be subpoenaed. Data can be categorized as personally identifiable information (PII) and non-PII. By their very nature, driverless vehicles must collect and retain large amounts of data related to the conditions surrounding the vehicle. Data collection methods are made possible by a series of lasers, radars, cameras, event-data recorders, and on-board computers designed specifically for self-driving. Each of these devices is critical for recording data about operations. As the technology matures, questions will continue about who owns the data, how it can be used, and how much control consumers have over it.23

Where do people go?

People utilize transportation for two main reasons: work and pleasure. Unless they telework, residents must utilize some mode of transportation (walking, biking, public transportation, or driving) to get to work. However, as demonstrated by the Metro SafeTrack year-long maintenance program, work cannot and will not always take place in traditional work locations. When necessary, both workers and businesses can and will adjust the way they operate. With increasing technological improvements and advancements, teleworking from home is becoming more popular and practical. The amount of people in the Washington, D.C. area who telework to some extent has increased from 2001 to 2013, from just 11 percent to 27 percent of area residents.24 A 2013 National Capital Region Transportation Planning Board survey of residents found that 50 percent of all commuters have the option to telework.25

The growing trend towards telework is evident when looking at the number of miles traveled per person versus population growth. Between 2007 and 2015, the area’s population increased 14 percent and employment increased 2 percent; however, the Vehicle Miles Traveled (VMT) on area roads only increased 1 percent, and Metrorail ridership actually decreased by 4 percent. Miles per person have decreased by 12 percent over the same period, and travel by public transit has remained fairly flat, even as the population has increased in the region.26
SECTION THREE
INNOVATION & ECONOMY

Autonomous vehicle technology is rapidly emerging from the realm of innovation to realization faster than governments have anticipated.

I. MEASURING INNOVATION

Measuring Innovation in the Private Sector

Autonomous vehicle technology is rapidly emerging from the realm of innovation to realization faster than governments have anticipated. The buzz around self-driving cars can be measured best using the number of innovative patents as a key indicator. Data from the Derwent World Patents Index demonstrates that from January 2010 through October 2015, there were over 22,000 automated driving related inventions. Even more telling is that the number of yearly inventions has nearly doubled in this timeframe, increasing from 3,000 in 2010, to almost 5,000 in 2015. A trend that will grow substantially as autonomous vehicle adoption increases among consumers.

Measuring Innovation in Local Government

Innovations in self-driving technology must translate to local governments and their long-term transportation plans. To date, the relationship between innovation and public policy has been incremental, at best. In 2015, the National League of Cities published a report to help city leaders understand, imagine, and plan for imminent changes in urban mobility. The report indicates a widening gap between growing innovation and transportation plans (only six percent of plans consider the effect of driverless vehicles) and notes that “people in most cities still only commute via car.”

Further, in a review of the nation’s 25 largest metropolitan area regional transportation plans (RTPs), all failed to incorporate self-driving vehicles, and only one made mention to this emerging technology. Additional studies find that planners are not including autonomous technology in their RTPs. This is not because public officials are unaware or skeptical of these vehicles, but is instead due to uncertainty surrounding the technology’s potential impact, and government’s inability to determine an accurate timeframe for implementation and investment.

<table>
<thead>
<tr>
<th>Plans consider the potential effect of driverless technology.</th>
<th>Plans take into account private transportation network companies (TNCs) such as Uber or Lyft, despite the fact that they operate in 60 of the 68 markets.</th>
<th>Plans include road diets or other plans to reduce road capacity or long-term maintenance costs.</th>
<th>Plans contain explicit recommendations for new highway construction, while 12 percent of plans are clear that no new highways are under consideration.</th>
</tr>
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<tbody>
<tr>
<td>6%</td>
<td>3%</td>
<td>20%</td>
<td>50%</td>
</tr>
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</table>

Source: National League of Cities

California, Washington, D.C., Florida, Michigan, and Nevada are the states with the largest legislation related to autonomous vehicles, and this year is focusing on determining how to accommodate autonomous vehicles operated by humans. Cities will need to determine the appropriate governance levels or zones for autonomous vehicles as well as develop policies that minimize the impact on current road networks.

In some fast-growing areas, highway construction plans are certainly justified, but even cities that have flat or shrinking populations are planning for expansion and more urban space. This indicates that many cities have not yet realized the potential for new trends to mitigate the rapid urban sprawl.
The EasyMile venture has deployed a driverless vehicle called EZ10. This EZ10 is a driverless bus and is currently set to operate in Singapore and California this year. Although road dependent, the EZ10 is not intended for public road use, rather it is expected to operate in business parks. The primary reasons for such inclusion are the vehicle’s maximum speed of 25 miles per hour, and lack of steering wheel, which presents no means to navigate from within the vehicle.

The Navya Arma bus was launched in October 2015. The bus is unique for a number of reasons: (1) it is the first entirely autonomous vehicle; (2) it charges via wireless inductive charging stations and can maintain a charge for 8 - 24 hours; and (3) it is equipped with a full suite of autonomous care visualization software that gives it accuracy within 2 cm. The vehicle was scheduled to deploy in the spring of 2016 in Scion, Switzerland. Its first routes will be performed on private roads where the vehicle can be monitored remotely.

II. LEVERAGING INNOVATION THROUGH COLLABORATION

Public Private Partnerships (P3s)

Innovation requires investment. For the full potential of autonomous transportation to be realized, local governments must invest in transportation infrastructure, new public service applications, and technology. Current estimates of the infrastructure costs needed to usher in the autonomous age exceed $500 billion. Additionally, the American Society of Civil Engineers grades America’s current transportation infrastructure a reprehensible D+, with estimates of over $3.5 trillion needed by 2020. With most local budgets unable to address their current transportation infrastructure needs, how are governments planning to account for the impending financial gridlock speeding their way?

Public-Private-Partnerships (P3s) offer solutions that utilize innovation and create economic opportunities that deliver significant benefits. Implementing P3s allows seemingly insurmountable challenges to be resolved by engaging a broad range of expertise and resources not typically available within a single organization. More simply put, P3s allow for increased collaboration among different actors with unique specializations.

P3s and Innovating Infrastructure

For most jurisdictions, the state government initiates and maintains roadways and project improvements. However, more and more jurisdictions are taking transportation infrastructure into their own hands due to increased service demands. Enhancing procurement, standardization, and management are three particular areas where P3s can play an important role in innovating public service delivery.

As self-driving technology develops, the standardization and intelligence managed by local governments will become increasingly complex. Seamless connectivity and communication between roadway infrastructure and autonomous vehicles will become an essential and compulsory requirement (similar to how white lines divide the roads today). Future vehicles will require roads to facilitate complex communication, such as global positioning and computer vision systems, so that autonomous vehicles’ ability to collect and act on enormous amounts of data is part of the infrastructure itself.

P3s help facilitate complex future infrastructure needs by: (1) encouraging the infrastructure life cycle management of technological improvements as they develop; (2) helping jurisdictions generate revenue that invests back into transportation plans; (3) facilitating vehicle-to-infrastructure (V2I) technologies and integration; and (4) developing dedicated means for depots, self-driving lanes, and smart networking that integrates ubiquitous connectivity.

P3s and Innovating Autonomous Public Transportation

In an effort to improve transportation access, the City of Altamonte Springs, Florida has partnered with Uber to create a revolutionary approach to public transportation. With this partnership, the city subsidizes up to 25 percent of the Uber fare if the ride originates within the city’s limits and ends at the Sun Rail Train Station. Thus, at the touch of a button, city residents are afforded a reliable and economical transportation solution. This collaboration is a primary example of how local governments can partner with private corporations. Doing so allows the city to meet its goals of improving regional transportation, promoting ride sharing, and leveraging technology through P3 collaboration.
For self-driving technology to be successful and provide a level of practical application, national standards are needed. Such an effort will rival any previously known level of public-private collaboration. To achieve the level of development and standardization needed, local governments must lead the charge. It is local governments that must partner and collaborate with industry leaders and educational institutions to develop sound regulations and establish appropriate benchmarks for the testing, infrastructure standardization, and development needed to safely usher in the autonomous era. Inter-agency collaboration will be required in ways that defy traditional paradigms. For instance, motor pool and technology departments will need to collaborate when managing and monitoring autonomous infrastructure. If local governments desire to be relevant, out-of-the-box thinking and future forward planning are required.

Collaborating with the Technical University of Delft and automaker Easy Mile, the Netherlands has worked to create and implement autonomous shuttles, known as WEpods, in just over two years. WEpods are modeled after EZ10 buses and are designed to carry a maximum of six passengers and travel along fixed bus routes. Similar to services such as Uber and Lyft, riders are able to book their seat on the shuttle through a mobile app. By the summer of 2016, WEpod service will expand to include additional preselected routes throughout the Gelderland province.

Technological Development and Standardization

Northern Virginia houses four 2,000+ parking space garages at its Metro stations. The Vienna/Fairfax - GMU location serves as the largest with 5,169 spaces. Reports conclude that electric vehicles have the potential to reduce carbon emissions by 25 percent when compared to internal combustion engines.
III. WHAT CAN SELF-DRIVING VEHICLES DO FOR THE ECONOMY?

The implementation of self-driving vehicles will affect local economies in many positive ways. One important area will come in the anticipated number of lives saved. Many studies indicate that technology is at the point where self-driving vehicles will be safer than human drivers. If self-driving vehicles can save lives by reducing the number of accidents, millions of dollars can be saved in medical care and lost productivity.

A decrease in the number of vehicles on the road, combined with the ability of self-driving vehicles to park in tight spaces, will translate to less crowded parking areas. In many major metropolitan areas, parking accounts for more than 30 percent of land use. If a new sharing model of autonomous vehicles can be developed, one where vehicles move from one destination to the next picking up and dropping off passengers, the need for extensive parking structures will be significantly reduced. The same holds true for traffic jams along major roadways. A reduction in traffic will lead to lower infrastructure costs. Local governments can, in turn, use these savings for other budget needs.

Self-driving vehicles have the potential to mitigate climate change through a reduction in greenhouse gas emissions. A majority of these vehicles will be electric, and on average, will reduce carbon emissions by 25 percent in comparison to traditional internal combustion engines. The Texas Transportation Institute recently published a study on the effects of traffic congestion and concluded that in 2014, 301 billion gallons of fuel was wasted due to road congestion.

The advent of self-driving vehicles will necessitate the creation of new jobs with differing skill sets. Without knowing how quickly and what new jobs may be created, it is difficult to determine how significant job losses in traditional transit-related sectors will be. Policymakers must consider the types of jobs that might be at risk, such as taxi and bus drivers. If local governments fail to plan adequately and defer self-driving technology leadership to private investors, the threat of deepening social inequalities will become a primary concern. Instead of creating uniform and equitable infrastructure development, the private sector has the potential to focus on wealthier and economically attractive locations, leaving a majority of citizens to fend for themselves.

The implications of governmental inaction in the face of the autonomous revolution will be significant. Jurisdictions stand to lose the opportunity to drive their own future. It is critical to start developing transportation plans today that envision tomorrow’s infrastructure, and maximize possible revenue sources and partnerships.

In 2012, 9.5 million cars in the U.S. were involved in 5 million accidents, resulting in 34,080 deaths, 2.2 million injuries, and 240,000 people being hospitalized. In the U.S. alone, the cost of accidents due to injuries, property damage, and lost productivity is estimated at more than $450 billion per year.
SECTION FOUR
INVESTING IN THE FUTURE

Investing in autonomous vehicle technology can improve the quality of life for residents in Northern Virginia.

I. SHAPING THE REGION’S FOCUS

The Washington Metropolitan Region has the dubious distinction of being ranked the most congested metropolitan area in the country. Despite the billions of dollars invested in transportation, at all levels of government, the region has been unable to resolve this crisis. As the growth of the region projects to increase at a blistering pace, the only hope to ease the gridlock may be the broad use of autonomous vehicles.

As the region’s population continues to spread outward from Washington, D.C. to Prince William and Loudoun County, resident commute times have grown increasingly longer. By investing in the infrastructure necessary to bring the region to the forefront of this new technology, autonomous vehicles can provide a significant return on the quality of life for the residents of the region by eliminating the average 82 hours individuals spend sitting in traffic each year and diminishing the $4.5 billion organizations accrue in lost productivity.

Facilitating the transition from traditional vehicles to autonomous vehicles will require forward thinking and investment from all levels of government. Local officials, specifically, need to start thinking about: (1) a potential for lost revenues; (2) where to find savings and new revenue sources; (3) new investment needs; and, (4) opportunities for innovation.

II. LOST REVENUES

With emerging technologies, governments need to think not only of future financial investments, but also about the potential for lost revenue. “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.”

Moving Violations

The revenue raised from driving-related violations, such as speeding tickets, red light violations and DUIs is expected to decline with driverless vehicles. These revenues are an important source of funding for basic government programs, including transportation infrastructure, schools, and public safety.

Traffic tickets generally come in two forms: (1) a moving violation, such as exceeding the speed limit, and (2) a non-moving violation, such as an expired vehicle registration. Parking violations are considered another type of a non-moving violation, with the ticket being referred to as a parking citation, notice of illegal parking, or parking ticket.

<table>
<thead>
<tr>
<th>Tickets Issued/Day</th>
<th>Tickets Issued/Year</th>
<th>Cost/Ticket</th>
<th>Revenue/Officer</th>
</tr>
</thead>
<tbody>
<tr>
<td>112,000</td>
<td>41M</td>
<td>$152</td>
<td>$300,000</td>
</tr>
</tbody>
</table>

Source: National Highway Safety Traffic Administration

$6,232,000,000 a year in revenue from tickets
Global Examples: London & Singapore

One specific way to raise new revenue from transportation infrastructure is to charge fees for using the area’s most congested roadways. This method is commonly known as Cordon Pricing. Two cities that have experience with this pricing structure are Singapore and London. Singapore has levied these types of variable tolls since 1975, and London since 2003. In 1998, Singapore’s tolling system became fully automated, similar to the Washington, D.C. region’s use of “HOT Lanes.” In London and Singapore, vehicles with electronic devices mounted in their cars, similar to EZPass, can electronically pre-pay or be charged for driving on restricted roadways. Fee schedules are tailored to the needs of the city, so vans, buses and low-emission vehicles may incur reduced fees.

Autonomous and connected vehicles, which can increase the carrying capacity of roadways and decrease congestion, may be incentivized through Cordon Pricing. As technologies evolve to allow for real-time communication with smart traffic management systems, electronic tolling systems will be able to tell not just whether a certain vehicle is on a roadway, but how it is being used. Therefore, Cordon Pricing schemes will be able to reward safer and more efficient driving decisions.

Singapore’s social and governmental systems allow for relatively austere policies regarding automobiles. In a 2013 article in Governing, the Singapore Land Transport Authority’s Chief Engineer for Transportation, Chin Kian Keong, stated; "We want motorists to know that there is a price to pay even before they start off their journey…We want to move people from cars, because cars are not such an efficient use of the limited road space that we have."

Shifting Tax Revenue

Governments must be prepared to explore additional ways to capture lost revenue from the elimination of accidents. As autonomous vehicles become more publicly adopted, revenues received from fines related to speeding, collisions, and driving while intoxicated (DUI) will decrease. The current practice of collecting tax on vehicle ownership can be converted to taxing vehicle use. Part of the fees collected for use of an autonomous vehicle could be dependent upon the distance traveled and distributed back to the localities in which the vehicle travels. This “pay-as-you-go” approach would proportionately affect all users.
Using a similar method as Oregon for data collection, reporting, and debiting could become standard practice for cars of the future, providing a payment platform that could be used to pay for insurance, parking, existing tolls, and other location-based services. Furthermore, this information could be examined to provide insight on road use to guide future transportation decisions and distribute road taxes to individual localities.

Changes, such as these, could allow localities to replace lost revenue by collecting funds that support transportation infrastructure investments; offer flexibility for collecting tolls; and incentivize autonomous vehicle use at the local level.

### IV. NEW INVESTMENT NEEDS

New technology brings new development needs. These needs come in the form of infrastructure, personnel, and more technology. For this reason, it is important to stay current with the requirements that accompany self-driving vehicles. Different classes of roadways will need varying degrees of investment in technology. Both highways and urban streets could utilize beacons that are placed along roadways to interact directly with autonomous vehicles. These beacons can regulate speed to control traffic flow, or to protect against travel during inclement weather on highways. In urban areas, they can assist with pedestrian signals, construction zones, and even with available parking inventory.

Traffic signals on current roadways will need to be upgraded in order to react with autonomous vehicles. Another technology that can enhance the level of interaction between roads and automated vehicles are Road Side Units (RSUs), which could gather information on traffic patterns and communicate these patterns to automated vehicles. This real-time data can have a significant impact on reducing commute times and congestion.

The level of financial resources necessary to implement beacons, enhanced traffic signals, and functional RSUs is unknown at this time; however, the investment that is made can help reduce the burden on existing government services, particularly public safety.
Local officials want to be known for their accomplishments in serving their community. As technology evolves and demographics shift, jurisdictions of all sizes must turn their focus on ways to steer this change in a positive direction. There are opportunities and challenges to all change; it is a matter of harnessing the opportunities, while thinking creatively to address the challenges that arise. As we navigate into the future, one thing remains clear, local governments must plan for the autonomous vehicle age.

**OPPORTUNITIES**

- Reduces the opportunity for human error, thereby reducing accidents
- Reduces carbon emissions into the environment by up to 25 percent
- Improves traffic congestion by limiting the number of vehicles on the road
- Enables ride-sharing, saving residents money on driving expenses
- Provides transportation for people with physical and mental disabilities
- P3s provide resources and expertise, allowing for greater innovation
- Frees up the region’s most limited and valuable resource: land
- Increases mobility options for the elderly and younger populations
- Increases productivity, which translates to the local economy
- Increases life expectancy and independence with more time to do things
- Helps police officers focus on criminal activity, instead of minor traffic infractions
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**CHALLENGES**

- Initial and continuous costs to update existing infrastructure
- Potential for increased substance abuse and other unsafe activities
- Challenge of humans and autonomous technology coexisting on roadways
- A shift in jobs within the transportation industry
- Intelligence managed by local governments will be more complex
- Additional PII information is generated and collected, leading to privacy concerns
- How will computers solve ethical dilemmas and unforeseen circumstances
- Increased cyber security threats and cyber carjackers
- Accessibility of the technology for all groups of people
WELCOME


SOCIAL IMPACTS


REGIONAL IMPACTS


INNOVATION & ECONOMY


INVESTING IN THE FUTURE

OPPORTUNITIES & CHALLENGES

PICTURES
As We Navigate the Future, Local Governments Must Plan for the Autonomous Vehicle Age