New Mobility
Autonomous Vehicles and the Region

A Report of the Fourth Regional Plan
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This report highlights key recommendations from RPA's Fourth Regional Plan for the New York-New Jersey-Connecticut metropolitan area. The full plan will be released in November 2017.

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Preparing the Region for AVs

Autonomous vehicles are one of the most exciting emerging mobility solutions, but also one with many unknowns. Will AVs be as transformative and as ubiquitous as smartphones have become in shaping how we think about moving around? Or will they be more like telecommuting – a trend that is still yet to seriously alter transportation patterns in the region? As Regional Plan Association embarked on the Fourth Regional Plan for the New York-NewJersey-Connecticut metropolitan area, we asked what role Autonomous Vehicles (AVs) would play in our region’s future, and how this should affect decisions about investments in transit, highways and local streetscapes.

- **AVs are coming.** While estimates vary, it is reasonable to assume a significant number of trips will be made in fully autonomous vehicles in our region over the next two decades.

- **Legal and privacy issues could delay adoption.** For example, there is no legal consensus on how to determine liability when an AV takes a life or causes injury.

- **On-demand mobility services will boom.** The expansion of AVs will continue to accelerate the adoption of transportation network company (TNC) services such as Uber, Lyft, and Chariot, by lowering the cost of providing these services.

- **There is no one-size fits all solution for communities to address AVs.** Physical planning strategies and regulation will need to differ by geography and time of day. Suburban issues include managing highway traffic, transitioning large areas devoted to surface parking, and adapting land use policies. In urban areas, regulating street space and addressing impacts on public transportation need to be priorities.

- **Transit will still play a fundamental role in higher density areas.** There is a lot of talk about how AVs will disrupt transit. But there is no AV technology that can carry the sheer volume of passengers taking the same point-to-point trips that are served today by our transit systems in high-density areas. We should be looking at opportunities for AV technology to be applied today to transit trips that are very expensive to provide because they serve far lower volumes of people (lower density areas, overnight service) or need to provide more bespoke service (paratransit). The arrival of AVs should be factored into cost-benefit analysis for new transit projects in lower density areas.

- **Several organizations are leading the way in this space nationally.** Bloomberg Philanthropies and the National Association of City Transportation Officials (NACTO) have convened working groups with city officials and industry leaders to begin to tackle some of the questions and challenges raised by a transition to AVs. Dozens of other groups and governments around the country and the globe are examining these issues and trying to better understand how to respond to this new technology.

The Benefits that AVs Provide

- **AVs will make us all safer.** They will reduce automobile fatalities and injuries. Over 38,000 Americans died in car crashes in 2015 and over 4.4 million were seriously injured. The impact of early automated safety features being introduced on automobiles today such as collision avoidance is encouraging.

- **We’ll get some time back.** The time now spent on driving will be “free,” which will reduce stress and allow passengers to be productive.

- **Seniors, the disabled and the young will be able to get around more easily.** AVs will clearly improve mobility for unlicensed drivers.

- **Goods should get cheaper.** Costs associated with moving goods (and their price to customers) could be substantially reduced if trucks were automated and if an alternate solution was devised (self-service and/or automation) to unload the vehicle.
Where We Need to Shape Policies to Ensure AVs Benefit Our Communities

- **We should shape how AVs interact with transit.** There is no question that traditional transit will still be vital to high-density areas even, or perhaps especially in the age of AVs. But AVs will likely compete with transit for riders, especially in the suburbs. Rather than repeat the mistakes of the last automobile age, adaptation should intentionally use AV technology to improve the reach, utility, and lower the cost of public transportation. AVs should complement existing transit service, helping to connect people to trunk lines in lower density areas, providing overnight service where volumes are low and potentially paratransit service with the assistance of aides to help with boarding and disembarking. In places where AVs are supplementing mass transit, fares should be regulated or subsidies offered to lower-income users. Governments need to guard against the risk that transit services are undermined by new AV shared-ride services which could siphon off wealthier riders, leaving lower-income residents with underfunded and diminished service options.

- **We should shape how AVs are used in the suburbs.** Smart AV policy will increase the attractiveness of ride-sharing and encourage compact development, especially near existing rail stations. If we don’t take appropriate action, private ownership of AVs will encourage more sprawl and increase congestion on our roadways and in our cities. Neighborhoods with walkable streets are associated with a more active lifestyle and lower risk of obesity. While AVs may be safer on the roads, if they decrease daily opportunities for walking, they could have adverse public health effects taking far more lives than vehicle crashes.¹

- **The business models for private shared-use vehicles are still emerging, and some of the most successful ones are not yet profitable.** Cities and towns should take this into account as they structure agreements with these companies to help fill gaps in public transit services.

- **Several hundred thousand professional drivers in this region could need new jobs.** This is part of a larger picture of secondary jobs that are built up around driving (parking garage attendants, traffic enforcement agents, rest stop staff), and is nested in an even larger shift towards automation that threatens jobs for unskilled or middle-skill labor, as portions of production and service jobs become automated. The direct impact of AVs on large, well-paid occupation sectors, such as truck driv-

AVs offer both great promise and peril depending upon how the technology is applied. What is clear, based on lessons learned from recent experiences from government with new “disruptive” technologies is that the time to act is now. Urban and transportation planners and regulators must be proactive to ensure that AV technology is safe and that we do not repeat the mistakes of the automobile era.

In cities, we can allocate more of the space between buildings for people while allowing for safe passage, pick-ups, drop-offs, and deliveries by AVs. In suburbs, we can repurpose vast acres that today are devoted to parking and encourage new forms of active mobility along with denser development around transit. AVs and other technologies can support these outcomes but only if their implementation is guided by smart policies that allow for innovations but also control for negative externalities, such as sprawl, congestion, and reduced public transportation ridership.

This is how the NY-NJ-CT region can begin to prepare.

Preparing for an AV Future

**Strategies for Urban Centers**

- **Prioritize street space for public transit, pedestrians, bikes, and freight.** Single-occupancy vehicles or low capacity multi-passenger vehicles be they AV or manually operated should get lower priority.

- **Implement vehicle-miles-traveled (VMT) fees or higher tolls to deter congestion.**

- **Cap the overall number of AVs (and remaining manually operated vehicles) during certain times of day or in the most congested parts of cities.** This would be similar to air traffic control at our region’s slot controlled airports. The Automated Vehicle Traffic Control (AVTC) could set a standard for other major cities and its operating costs could be paid for by a VMT fee surcharge on those entering the congestion zones.

- **Use geofencing to implement these caps or to restrict vehicles from certain areas during certain times of day.** For example, New York City might choose to make Broadway from 59th Street to Union Square fully car-free from 8 am – 7 pm.

Provide sufficient curb space for pick-up/drop-offs and deliveries to not impede the free flow of traffic in mixed-lanes.

Reduce off-street parking requirements and eliminate on-street parking for long-term vehicle storage.

Prioritize affordable, high-quality transit. Policies should promote the integration of AVs into public transit with the goal of continuing to provide high-quality service at affordable prices across a wide economic spectrum. AVs also offer the potential for providing better microtransit service that fits special use cases (e.g. paratransit or late night service) at much lower cost than today.

**Strategies for Suburban Areas**

Continue to promote transit and the use of AV to link to transit hubs. This would control congestion on regional roads and allow the repurposing of parking lots at local transit stations.

Subsidize on-demand AV transit services to improve mobility for the disabled, young and elderly within the suburbs. This can replace more expensive options being used today.

Discourage private AV use by scaling VMT fees to the number of passengers in a vehicle, making it more expensive to travel far distances alone. Ideally, a portion of VMT fees captured could be redirected to subsidize transit costs and encourage compact, transit-oriented development. Otherwise, personal AVs could dominate the auto travel industry inducing and/or reinforcing existing sprawl.

Encourage vehicle sharing. Substantially reducing parking requirements for buildings and charging higher VMT fees for vacant vehicles (except delivery vehicles) to encourage shared vehicle use over private AV ownership.

A clear, actionable, and uniform set of data standards should be developed and deployed nationally (at a scale to make it worth it for OEMs) that give local, regional and state governments the data needed to manage the network, manage transit, curb space, and traffic safety to optimize across modes and service providers for public policy goals. A third party might be better placed to facilitate dialogue between government and private sector and to develop these standards.

- Fare payment should be seamless and compatible with future regional open payment system.
- Service should be coordinated between AVs and high capacity, high frequency, fixed long-haul transit (i.e. subway, commuter rail, intercity higher-speed rail and aviation). AV timed arrivals and departures should be coordinated with physically fixed services.
- Data with public significance for traffic crashes and mobility indicators should be open and accessible to all and public agencies should integrate this into their data and planning policies.

AVs must be safe and low-carbon. All AVs should have the most modern safety features and a system for upgrading software and hardware as innovations occur. All AVs should have the lowest possible carbon footprint, with cities making investments to encourage the adoption of hybrid and fully electric vehicles.

Our communications infrastructure needs a boost to support the deployment of AVs. Today’s communications infrastructure is both insufficient and fragmented. This represents an opportunity to expand its reach alongside the spread of AVs.

**Equity, Accessibility, and Affordability Strategies**

Shared AVs provide an opportunity to greatly reduce transportation costs for lower-income households through offering alternatives to the high costs of full-time car ownership— including parking, gas, insurance, and the car itself. If held to proper accessibility requirements, shared AVs also present a far more flexible mobility opportunity for disabled and elderly people.

Low and middle-income households in transit deserts are among the most likely to currently use taxis and jitneys as a primary form of transportation because of inaccessible transit and low car ownership. Providing more economical options for point-to-point transit could greatly help low-income people and families.

To ensure value for those in the lower to middle-income brackets, shared AVs need to be regulated with pricing policies. In addition, the societal value gained from moving toward AVs needs to be distributed fairly and in a way that ultimately reduces costs for low-income households.
Pricing policies need to be clear and transparent, and car-sharing options should be available, accessible and affordable.

Shared AV service must serve all communities. Governments should ensure that current non-discrimination on the basis of destination rules apply to AVs or pass new legislation to prevent higher costs and fewer options when traveling to or from lower-income geographies.

Governments should consider subsidizing shared AV services to provide discounts for low-income residents, seniors and the disabled, similar to transit passes.

Governments should rezone and repurpose parking lots, especially around rail stations to help provide more affordable housing. These spaces will become available for alternative use & development once AVs are fully established. Governments should reclaim this space to help relieve the housing affordability crisis in our region by adding housing and requiring mixed-income developments.

Workforce Adaptation
Automation is rapidly changing the nature of jobs across the country, creating new ones but taking others away. Automated vehicles by their very nature will mark the end of the professional livery, TNC and taxi driver, and over time this technology will also likely displace bus and paratransit operators. The trucking industry will also be substantially impacted, possibly as one of the earliest adopters of automation, displacing over 3.4 million professional truck drivers nationwide.²

There are about 220,000 motor vehicle operators in the RPA region.³ These occupations, which span the trucking, taxi, black car and bus sectors, are among the shrinking number of well-paying jobs that generally do not require a college degree. It will be essential that there be pathways into different careers for those workers whose jobs are replaced by AVs.

Federal, state and local governments in partnership with the private sector should begin planning for greater automation and its impacts on the nation’s labor force.

The region’s transportation agencies should start negotiating with labor now to determine how this transition might take place and how to prepare drivers to transition to new roles. Without a plan for transition, unionized labor is likely to resist automating public transit and could make it even more vulnerable to losing riders to private sector transportation providers. Private sector regulated TNCs such as Uber and Lyft also have labor forces large enough to force changes and may spread unionization to the private sector.

An institute should be created to retrain the displaced workers from the livery, public transportation, and trucking industries. Businesses where the workforce is impacted and governments should be required to fund this program if they do not offer these services to their employees.

This brief provides an overview of AV technology, the barriers to adoption, and when we should anticipate AVs in the region. It analyzes current and past trends that could affect AVs and evaluates how AVs might impact the built environment in our cities and suburbs. Finally, it summarizes RPA’s findings and guidance for preparing for the eventual rise of AVs.

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While discussions about autonomous vehicles rely on guesswork and statistical projections that make it difficult to pinpoint an exact timeline, it is clear that the adoption of autonomous vehicles is just over the horizon. Google’s autonomous vehicle group, Waymo, currently operates AVs on public roads in California, Texas, Washington, and Arizona – logging about 1.5 million miles as of July 2016 and doubling that by May 2017 to 3 million miles. Numerous manufacturers have begun testing their own fully driverless passenger models, including Audi, Cadillac, Ford, GM, Mercedes-Benz, Nissan, Toyota, Volkswagen and Volvo. Meanwhile, semi-autonomous driverless technologies have already been introduced in current production models, allowing for adaptive cruise control (ACC), parking assist systems, lane departure warnings, collision avoidance and on-board navigation.

Autonomous technology shifts the manual process of operating vehicles to intelligent machines. It will spur changes across the mobility sector that can greatly improve accessibility and safety in New York City and its suburbs. Autonomous vehicles have the potential to reduce the traffic deaths for people walking, lowering the 136 pedestrian fatalities that occur in NYC each year and the 224 that occur in the rest of the region each year. The tri-state area region’s large population suffers from growing income inequality. In Bronx county alone, there are 421,225 individuals living under the poverty line, or 30.7% of the borough’s population, who have few mobility options they can afford (i.e. owning a car). Communities in the region need better access to transit, but high operational costs constrain the provision of more frequent and affordable service. Autonomous vehicles could help address the

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6 Annual average in NYC from 2012-2016 using NYC DOT and NYPD data. Annual average in rest of region from 2012-2014 sourced from Tri-State Transportation Campaign.
issues of affordability that come with accessibility, but they will also be revolutionary for goods movement and waste management.

The Race to Innovate

There are many estimates made on how long it will take to transition to a fully driverless fleet, most indicating a major transition over the next 20 to 40 years. However, it is likely that the region will begin to experience low levels of driverless cars on roads before then. For instance, Ford plans to mass produce driverless cars by 2021 and use them for a commercial ride-hailing service. Mark Fields, Ford’s former CEO, has said, “We see autonomous vehicles as having as big an impact on society as Ford’s moving assembly line did a hundred years ago.” Volvo has partnered with Uber to develop fully self-driving taxis by 2021, although they are already picking up customers with partially autonomous vehicles in Pittsburgh. Telsa’s CEO, Elon Musk, predicts a slightly more aggressive AV release in 2018, but also feels that state regulations may prevent a single nationwide introduction. A study completed by the Eno Center for Transportation estimated that it will take another five years beyond rollout for prices to drop to allow for mass-market penetration. The New York Institute of Electrical and Electronic Engineers (IEEE) predicts self-driving vehicles will make up 75 percent of vehicles on the road by 2040.

In 2013, the National Highway Traffic Safety Administration (NHTSA) released a preliminary policy on automated vehicles defining five levels of automation, starting at zero (Figure 1). Many of the companies investing in autonomous technologies believe in an incremental approach that releases level 2 or 3 semi-autonomous technologies to the public as they continue to develop their technologies to reach full autonomy.

Evolution of AV Technology

Public discourse concerning autonomous vehicles has come a long way since its first experiment in the 1990s, when the U.S. DOT’s Automated Highway System (AHS) research suggested that vehicle position could be detected by magnetic fields from magnetic nails in the road surface of designated lanes. These plans for driverless vehicles would have required significant investments in infrastructure to connect the road and the vehicle. Building upon AHS research, the Intelligent Vehicle Initiative (IVI) in 1998 shifted focus to vehicle-based and infrastructure-cooperative assistance products in order to reduce the number of crashes on highways.14

Recent research suggests that the most imminent transformations in the automobile industry will center on vehicle-to-vehicle (V2V) and vehicle-to-infrastructure (V2I) technologies.15 V2V requires on-board dedicated short-range communication devices that are able to transmit and receive messages about speed, heading brake status, etc. At a minimum, vehicles need a two-way dedicated short-range communications (DSRC) radio and a GPS receiver to derive the vehicle’s speed, path, and acceleration patterns. These more advanced autonomous vehicle systems will move beyond the imperfection of physical obstruction sensor systems in order to communicate directly with compatible infrastructure or vehicle transmitters. By communicating through omnidirectional radio or laser signals, vehicles equipped with V2V can detect others around corners or behind obstacles that vehicles using sensors would not. This system enables semi-autonomous safety applications, including blind spot warning, lane change warning, intersection movement assist (IMA), forward collision warning (FCW), left turn assist (LTA), instant braking and acceleration signals.16

Over the past decade, some of the most significant development of self-driving ground vehicles has been fostered by the Defense Advanced Researched Projects Agency (DARPA), a research institution that is part of the U.S. Department of Defense. DARPA’s work is focused on accelerating the development of autonomous vehicles so they can substitute for humans in military operations. To encourage the development of driverless cars that use various positioning sensors, DARPA has hosted a series of challenges, or prize competitions, for American autonomous vehicle development. In each competition DARPA has leveraged researchers beyond traditional military sources, including various innovators, engineers, students, programmers, off-road racers, and backyard mechanics.17

Despite the proven successes of technology in DARPA’s challenges, manufacturers’ prototypes and other research, the transition to a fully driverless fleet also depends on the willingness of society to adapt and institutionalize regulations. The same trends that have likely sparked car share use – low rates of licensed drivers among younger generations, concern about environmental impact, growth of the sharing economy and a return to the urban lifestyle – indicate that much of our society is ready to move in the direction of autonomous cars that will enable more efficient car share models. In the words of Dr. Myra Blanco of Virginia Tech Transportation Institute, “people increasingly want to be supervisors of their vehicles, not operators.”18 Yet, many critics warn about the eagerness to trust such technology and pose questions about its legal, security, and safety complications - all which are addressed in greater detail in this brief.

15 Ibid.
17 To read more about the DARPA challenges, see: http://archive.darpa.mil/grandchallenge/overview.html.
Progress Made by Manufacturers

Car companies have explored a variety of marketing strategies for incorporating the technology into their products. Mercedes Benz delivers a “luxury carriage” for private relaxation and socialization with their F-105 concept car, while Ford asserts a goal to “democratize” the market with less expensive autonomous vehicle options. Yet Ford is also aware that the prediction of increased ride sharing will make fewer of these vehicles necessary in the future, inspiring it to acquire Chariot, an on-demand shuttle service. Google has also targeted urban areas as the ultimate testing ground for autonomous driving, because it requires the vehicles to rely on complex maps and operate in an environment with various obstacles such as cyclists and pedestrians.

In August 2016, Delphi was tapped by Singapore to begin a pilot program for the world’s first automated taxi program using Audi SQ5s. This program will last until 2020, running on a four mile loop in Singapore’s One-North business district, with an option at its culmination to transition to a larger scale operational program. Anticipating the applicability of AV technology to the services offered by Transportation Network Companies (TNCs), Uber has invested $500 million in its own mapping software that will make detailed maps including information pertinent to picking up and dropping off passengers. As a solution to the increasing trend of mobility services, Tesla has announced that it envisions a program that will allow self-driving vehicle owners to deploy their cars in a shared fleet that will generate income while their cars would have been parked.

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Are We Moving Too Fast?

In 2014, Mercedes-Benz released S-Class vehicles with “Intelligent Drive” functions that permit automatic speed adjustment, lane keeping assist, and autonomous braking if an obstacle is detected. Just two years later, it began advertising a feature called “Drive Pilot” for its E-Class, priced from $50,000, which Consumer Reports and the Center for Automotive Safety felt was falsely advertised. These two watchdog organizations were concerned that consumers would believe that their vehicles no longer required their attention and could operate with full autonomy.\(^{25}\) The potentially dangerous repercussions of prematurely removing human oversight, as well as the legal complications of self-driving vehicle accidents, became a real public concern following the fatal accident involving a passenger in a Tesla on Autopilot (a semi-autonomous operation mode) in June 2016. Mercedes-Benz has since explained in promotional videos that drivers must keep their hands on the wheel of their vehicles. If the vehicle senses an absence of hands on the wheel, it will prompt the driver to correct their behavior like the beeping sound of an unbuckled seatbelt. If no action is taken, the vehicle will decelerate and stop.\(^{26}\) Tesla has been working to incorporate a similar safety feature, after its only fatal accident to date was discovered to occur when the vehicle was moving for 40 minutes with only 25 seconds of driver engagement with the wheel.\(^{27}\)

When Uber began piloting its autonomous vehicle in San Francisco without officials’ permission, the vehicles exhibited many of the most dangerous driver behaviors – running through red lights, making unsafe right turns in front of bike lanes, and failing to yield to pedestrians.\(^{28}\) In the upcoming years, as vehicles transition to fully autonomous capabilities, safety may be the biggest concern. If and when it reaches full market penetration, questions about infrastructural capacity and maintenance will become more important.

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While Level 4 and 5 autonomous vehicle technology might be mature enough to release soon, the market penetration of these cars depends on several factors. Cities like Singapore have demonstrated interest in developing autonomous taxi programs and buyers of Tesla and other luxury brands have demonstrated their desire for personal transport with autonomous features. Tesla experienced a 60% increase in sales between 2014 and 2015, but growth slowed between 2015 and 2016, with a sales increase of only 10% (based on estimates, since the company has denied release of specific sales data). Mercedes-Benz doubled its sales in 2014 after the introduction of semi-autonomous technology on S-Class models. Regardless of public interest, legal regulations, cost impediments, and cultural factors may delay the integration of autonomous vehicles into society.

Regulations

It is often regulatory bodies, tasked with the safety of users rather than promoting technological advancement, which delay adoption. Thus, it is imperative that regulatory and policy barriers be identified early to determine what existing rules must be altered or new ones created to foster a safe but timely transition. At the federal level, the Intelligent Transportation Systems Joint Program Office (ITS JPO) at U.S. DOT is hosting research on connected and autonomous vehicles. The agency is actively looking at national regulations that must be put in place to ensure a safe network of autonomous and manually-operated vehicles. In August 2014, ITS JPO in partnership with NHTSA released an advance notice of proposed rulemaking (ANPRM) and a supporting comprehensive research report on V2V communications technology.

The National Association of City Transportation Officials (NACTO) has outlined several principles for automated vehicle policy in the immediate future.

- Federal and State level policy for infrastructure funding should be revised to reflect the future restructuring of our transportation system, and transportation models should also change to reflect these changes.
- Expressway plans should emphasize modernization over expansion, so that wayside infrastructure is ready to accommodate potential AV needs.
- Federal policies should develop data-sharing requirements for new vehicle technology.
- Increased safety is promised by AVs, but the road to flawless technology will require testing on public roads that should minimize risk for passengers, pedestrians, and cyclists. In city streets, the maximum operating speed should be 25mph, and use of partially automated vehicles should be limited to controlled environments like highways.

NACTO will release more comprehensive guidance in the fall of 2017.

In September 2017, the U.S. House of Representatives passed Safely Ensuring Lives Future Deployment and Research in Vehicle Evolution Act or the SELF DRIVE act. The Senate is currently drafting its own bill, called the AV Start Act, which will address some of the missing pieces from SELF DRIVE. The act passed in the House of Representatives would give the NHTSA power to regulate autonomous vehicle design, while states would have authority over vehicle registration and licensing. It also would require companies to have “privacy plans” stating how they will collect and use passenger data. NHTSA regulates how vehicles are designed through the Federal Motor Vehicle Safety Standard (FMVSS), and today it is able to grant 2,500 exemptions each year. Since FMVSS mandates the inclusion of a steering wheel and brake pedal, companies like Waymo testing fully autonomous vehicles...
must receive one of these exemptions for each vehicle. The new legislation would allow the NHTSA to grant 25,000 exemptions in its first year, making it possible for ten times more fully autonomous vehicles to be tested on roads just in year one. In year two, the number of exemptions would be increased to 50,000, and in years three and four, 100,000 exemptions would be permitted.

While this legislation is good news to automakers, some groups are concerned that the new onslaught of vehicles using public roads as their safety testing laboratories could be dangerous. The legislation is unclear about whether cities and states will retain the authority to regulate testing or ban them completely, despite the increased allotment of FMVSS exemptions. Additionally, manufacturer liability in the event of a crash is not addressed, nor are streamlined data sharing policies. The Senate’s revised self-driving vehicle legislation aims to resolve some of these questions.

Shortly after the House of Representatives passed the SELF DRIVE act, NHTSA released voluntary guidance concerning Automated Driving Systems (ADS), outlining the safety features that should be incorporated into the design of ADS and aiming to define the role of state legislatures and highway safety agencies in establishing vehicle testing rules, encouraging competition, and regulating insurance and liability. The guidance asks states to allow NHTSA alone to regulate the safety design and performance aspects of ADS technology through FMVSS in order to avoid conflicting federal and state laws.

In our region, autonomous vehicle legislation has been introduced in New York, New Jersey, and Connecticut. Governor Cuomo announced in May 2017 that New York is accepting applications from companies wishing to test vehicles, while stipulating that they must submit a safety study with recommendations to the Commissioner of Motor Vehicles. Drivers are not required to have their hands on the steering wheel while steering technology is engaged, enabling autonomous vehicles to drive on public roads as long as the driver is present and able to take over. Both pieces of AV legislation are valid for one year and then will be reassessed. Connecticut passed AV legislation in June 2017 that established an AV testing pilot, allowing up to four municipalities to host such programs under the condition that they provide assessments of the tested technologies and recommendations on how Connecticut should legislate and regulate AVs. In New Jersey, testing of autonomous vehicles is permitted only for manufacturers that have passed the state’s application process and received proper licensure. Tesla’s Director of Autopilot Programs, Sterling Anderson, has attempted to accelerate the legal process by offering to share over 780 vehicle-miles of data from their Autopilot program with the USDOT. He believes that regulators will “want to see billions of miles of data to show that it is statistically true that there is a substantial improvement in safety if a vehicle is autonomous versus non-autonomous.”

### Liability

Fully autonomous vehicles will have no human operators — only passengers. So who will be held accountable if a vehicle takes a life or causes physical injury? The 2016 Tesla crash was the first fatal collision that occurred with a driver and a semi-autonomous vehicle. While Tesla has denied that it was an issue with their Autopilot feature, the incident spurred debate about the ethical and legal dilemma concerning AV crashes: What if a fully autonomous vehicle has an accident? And what if it causes the injury or death of its occupants, a pedestrian, cyclist, or the passengers in another vehicle? To whom does the victim(s) or their family direct their legal claim — the owner of the AV, car manufacturer or the program developer? A legal agreement in which the AV owner must take responsibility would make driver-free commutes a less appealing option. Owners would feel a need to pay attention, else face serious legal repercussions. The cost of new car insurance policies could also seriously compromise the market appeal of autonomous vehicles.

Some places have already started to wrestle with these issues. California decided that 30 seconds of sensor data prior to a collision will help establish fault. Fully autonomous vehicles will likely not have a steering wheel, but during the semi-autonomous phase of their development with an emergency stop built into the car, would passengers be able to catch an AV mistake before it happens? This places the legal burden on the company who designs and manufactures the vehicle.

NYU Professor of Civil Litigation, Mark A. Geistfeld, has examined the likely course of autonomous vehicle liability and suggests that the transition from individualized

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driving to systematized driving will place liability on the manufacturer based on the performance data for the fleet. Manufacturers will need to adequately warn consumers about the risks of autonomous technology and treat both passengers and bystanders equally in the programming of the operating system in order to minimize liability.43

So if manufacturers assume responsibility for fatalities and injuries, should there be laws to cap their exposure to law suits? The aircraft industry, which also handles complex, mostly automated machines, has addressed this question. The Montreal Convention in 1999 outlined carrier liability for deaths and injuries aboard international flights along a two-tier liability system. The carrier is indisputably responsible for compensation up to 100,000 SDR (special drawing rights, defined by the International Monetary Fund, equivalent to about $140,000 per air passenger). For damages beyond that amount, the carrier may seek defenses by proving that it was not at fault.44 The challenges related to these legal questions could add up to a considerable barrier to market penetration of AVs and suggest that they might be considered illegal until accident liabilities are firmly defined either through legislation or by the courts.

Higher Costs?

Cost impediments present another challenge to AV’s market penetration. The private sector will evaluate overall costs including the technology itself, insurance and risk, replacement costs and cycles to their fleet as well as decreased labor costs over time when deciding whether to adopt new technology. For individual consumers many of these decisions will happen at a much smaller scale.

While Ford has suggested that it is interested in developing an economy autonomous car, models on the market today with semi-autonomous features are not affordable to the middle class. Tesla has made autopilot available in all its vehicles since September 2014, and it costs an additional minimum of $3,000 to activate, with the least expensive Model S 60 costing a baseline $68,000.45 However, the expected release of Tesla’s more affordable Model 3, starting at $35,000, has already attracted 450,000 preorders while Ford has suggested that it is interested in developing an economy autonomous car, models on the market today with semi-autonomous features are not affordable to the middle class. Tesla has made autopilot available in all its vehicles since September 2014, and it costs an additional minimum of $3,000 to activate, with the least expensive Model S 60 costing a baseline $68,000.45 However, the expected release of Tesla’s more affordable Model 3, starting at $35,000, has already attracted 450,000 preorders for delivery in 2018.46 Tesla’s fully self-driving LIDAR and radar system will cost $8,000.47 Mercedes-Benz charges $140,000 per air passenger).

In 1981, the Grimshaw v. Ford Motor Co. case revealed that Ford had known about a faulty design that resulted in punctured gas tanks during rear-end crashes that would then ignite causing the vehicle to be engulfed in flames. Ford had waited eight years to make any modifications to its design, because it had conducted a cost-benefit analysis that “placed a dollar value on human life,” according to the Mother Jones exposé in 1977.4 Despite records found in Ford’s possession that documented ruptured fuel tanks during each one of the 40 plus safety tests conducted on the Pinto, Ford decided that it would be more costly to recall the cars and make safety modifications than handle legal fees for the fatal crashes, estimated between 500 and 900, that took place.

This story is not unfamiliar for the car industry. In 1968, the Larsen v. General Motors Corp. case landmarked the necessity for automobile companies to take safety into consideration during their design processes. General Motors claimed it had no duty to protect the occupant during an accident, but the court disagreed.4 While these issues were early bumps in the road to more safety conscious designs, car companies today still make decisions to ignore safety flaws once discovered. Just as Ford placed a value on human life, autonomous vehicles will have to make life and death decisions. Is it the responsibility of the programmer and artificial intelligence technology to teach the car how to make those decisions? What if Ford finds a costly flaw in its technology once its first AV is released? Will history repeat itself?

Slow Pace of Consumer Adoption

Adoption and acceptance of new technologies takes time for many reasons. While AVs may be ready in the near-term, the typical lifecycle of vehicles, higher initial costs and concerns over safety will slow down the transition. In a 1986 study of technology diffusion within the automotive industry, new technologies usually took between 10 and 20 years to reach market penetration from their introduction. The mass transition to automatic transmissions, an automotive technology innovation that’s comparable to autonomous driving technology, took about 35 years. However, the quickly dropping cost of lithium ion batteries for electric vehicles and the resulting climb in sales may mark a change in pace of consumer adoption for new technologies. The public’s adoption of AVs may be compromised by the perceived danger of riding in a self-driving vehicle. Understandably, it is hard to place one’s own safety in the responsibility of an artificial intelligence technology, and because so much data will be available, it is very likely that information collected from autonomous vehicles will be invaluable to their planning processes.

Privacy Concerns

Those who are already suspicious about the amount of data collected about our personal lives and habits through GPS, smartphones, and the internet will presumably be concerned about the data made available from autonomous vehicles – both privately owned and on-demand services. Particularly if our identity is connected to the payment system and travel patterns are collected, this information could be used to track individuals. There could be no way to travel “off the grid.” Even today, many cars on the market already collect driving data and store it off-board. Data ownership and control remain undefined in U.S. and state legislatures. Eno’s 2013 report raises five questions to discuss as this technology advances: “Who should own or control the vehicle’s data? What types of data will be stored? With whom will these data sets be shared? In what ways will such data be made available? And, for what ends will it be used?” Particularly in city systems, public agencies and private automobile and technology companies will have to negotiate these agreements, which will likely raise suspicion from big data critics. Current reluctance from TNCs to share rider demand data foreshadows the difficulty in convincing future OEMs to share their information for public use and benefit. If government agencies are successful in establishing a data sharing standard with OEMs, it will be invaluable to their planning processes.

Security and Hacking

Because so much data will be available, it is very likely that information collected from autonomous vehicles will be coveted by hackers. Security systems will need to be strengthened significantly. If cities are relying on automated systems for the majority of their transportation services in the future, the potential for a hacker to shut down the system could be devastating. Even worse, hostile nations or terrorist organizations could cause damage by rigging crash prevention systems to fail. To date this has not been the focus of most hackers. Jason Hickey, vice president of software security firm Vínsula, says there are...
more cyber-attacks with the intention of collecting information than actively disrupting a system’s operations, since the latter is a more difficult task. The National Institute of Standards and Technology (NIST) has presented a framework for cyber-resiliency that will make autonomous vehicle infrastructure more difficult to hack. Yet, they will not be impervious to all exploits and determining how vehicles will react when they are compromised will be critical in assuring the public of autonomous vehicles’ safety.

What About the Drivers?

Autonomous technology brings large public safety benefits, but it also allows truck, transit, and livery service industries to reduce their labor forces and cut costs. Labor unions protecting the jobs that will be replaced by autonomous technologies across sectors—transportation, retail and more—are rightfully concerned about automation. The concerns of subway, bus, and taxi workers will likely result in some political backlash. When the L train began transitioning to Communications-Based Train Control (CBTC) in 1999, the MTA faced challenges by the Transit Workers Union (TWU) Local 100 that suspended the shift to one person train operation (OPTO) – a transition that was originally used as one of the justifications for the investment. Policy makers need to consider the impact of automation on employment on the transportation sector. What positions will this displaced workforce assume in the 21st century? Public-sponsored job training or public-private models that companies driving the advancement of this technology pay into could provide the skills that allow former drivers to transition into new roles at similar wages. However, the impact on unskilled labor is likely to be significant.

The Trolley Problem

The ethical complications of AV responsibility are tackled head-on in an application developed by MIT Media Lab’s Scalable Cooperation research group called “The Moral Machine.” The online simulator allows people to experience the same moral dilemma that an AV would during a situation where a fatality is inevitable. The Moral Machine can crowdsource human opinions on how machines should handle ethical choices and mimic the “Trolley Problem”, a popular ethical thought experiment. The Trolley Problem postulates a scenario where a runaway trolley is running along a track with a switch just ahead. The switch is set to a track where five people are tied up and unable to move in the trolley’s path. On the other track stands just one man who is also immobilized. If you were able to pull a lever to change the trolley’s path and kill one man instead of five, what would you do?

Human judgments are also influenced by race, socio-economic status, body type, age, and gender of the lives in question, which AVs may or may not consider depending on their programming. “The Moral Machine” takes these factors into consideration to see how people assess the value of human life in different situations. Information collected from the project could be invaluable for programming AVs, but it also points out flaws in human judgment. Do we trust machines to make an informed decision on the value of a life? Humans act out of split-second intuition, which is not always rational but can be creative, and we assume fallibility for their driving decisions. But when autonomous vehicles make crisis decisions, they will make an analysis that will inevitably judge one fatal scenario less tragic than another. In the end, they will make the cold decision on whose life to risk, and it could sometimes be the passengers that have placed their trust in the technology. The inevitability of these situations could deter some individuals from investing in fully autonomous vehicle technology.

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56 Ibid.
57 Ibid.

A Prospective Timeline in Four Phases

1. **2017-2022**
   Automated features continue to improve and become less expensive, while car ownership declines.

2. **2022-2027**
   Fully autonomous vehicles are on the market, but AV and legacy vehicle mix results in uneven traffic improvements.

3. **2027-2040**
   Autonomous conversion of light-duty vehicle fleets increases from 15 percent in 2030 to 75 percent in 2040.¹

4. **2040 and beyond**
   Land use planning is permanently altered to make way for pedestrians, cyclists, and public spaces, in both urban and suburban streets.

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The Road to AVs in the Region

Developing a timeline for the rollout of AVs requires making many assumptions, some of which will likely not play out as anticipated. Nevertheless, it is clear that autonomous vehicles are coming and we should attempt to understand roughly when they will be entering our market and what capabilities they might have. This timeline considers barriers to implementation in combination with the general consensus among technology experts that there is real pressure to develop these technologies to realize their social and commercial benefits. RPA has also looked at the New York region’s fleet mix and auto ownership rates to gauge more quantitatively how quickly this transition might take place and in what form.

In the past, sustainable practices in public transportation planning in urban areas has largely focused on diverting user preference away from automobiles, in an attempt to decongest city streets and decrease the contribution of gasoline emissions to cities’ carbon footprints. But autonomous vehicles present a potentially positive contribution to urban transportation systems, if the fleet can eventually transition to completely electronic vehicles, riders and vehicles are shared, and it can be integrated into the existing public transit system – moving away from single occupancy vehicles and reducing the need for parking. The more saturated the market is, the better the chances that predicted benefits will come true, including fewer vehicle-induced injuries and fatalities and a conversion to a shared ownership model that would lead to fewer vehicles on the road, thereby decreasing gasoline emissions and need for parking space.
Trucks move over 10.5 billion tons of freight every year and are integral to the region’s economy. The disparity between supply, the number of available truck drivers, and demand for goods has created a problem that autonomous vehicle technology could help to solve. The trucking industry is ripe to adopt new technologies because their labor costs are relatively high and rising, fuel costs are high and rising, and trucking companies are beginning to re-invest in their capital fleet due to aging fleets and stricter emissions regulations. When they choose to do this, it’s likely they will start to transition to AVs. Furthermore, the predictable environment in which trucks operate could make them a safe beginning for autonomous technology ventures.

While much of this brief focuses on the changes that autonomy will bring to passenger vehicles and transit, the long-haul trucking industry will likely be the first to embrace autonomous technologies. The trucking industry employs nearly 3.5 million people and delivers 70% of all freight, but in recent years has experienced a shortage of drivers which has led the American Trucking Association to predict a deficit of 75,000 drivers by 2024. The driver shortage is attributed to a high average age of drivers and a limited employee demographic pool: only 5.8% of truckers are women. Lack of time spent at home, few career advancement opportunities, and long nights on the road make truck driving unappealing. With autonomous technology, truck drivers today could skip the strenuous schedule and lifestyle of a long-haul truck driver and maintain their jobs as delivery hands along the truck’s route. In 2011, the USDOT instituted “House of Service Rules” for truck drivers that limited the number of hours they could drive continuously to improve driver health and highway safety. This placed additional pressure on freight companies and municipalities (to provide truck parking, rest stops). Freight companies could move loads more efficiently and with fewer delays (elimination of rest periods) while cutting costs and addressing the increased demand. “Platooning” technology would allow autonomous trucks to move with a shorter distance in front of the vehicle. Chains of platooning trucks could carry large loads and communicate with each other using V2V technology.

Highways are simple environments for autonomous vehicles to navigate, making trucks a target for early autonomous technology testing. Additionally, truck platooning could help mitigate fuel inefficiency issues. The North American Council for Freight Efficiency (NACFE) found that “platooning,” when cars or trucks follow each other at constant speed, could create 4.5 percent fuel savings for the lead truck and 10 percent from the following trucks.

Autonomous truck startup Otto was one of the first of its kind, which has been acquired by Uber. It planned to retrofit existing truck cabs with lidar, radar and cameras for a fraction of the cost of a new cab. Co-founder Lior Ron noted that a truck can only drive 11 hours a day with a single driver, per government regulation, and after 10 hours the accident rate grows exponentially. An autonomous
truck fleet would make that safety risk obsolete. Today, Otto has been integrated into Uber’s Advanced Technologies Group and has been operating very few vehicle miles on the road.65 Several other autonomous trucks startups have followed in Otto’s wake, such as Embark, Tusimple, and Starsky Robotics, which has equipped trucks in Florida with its autonomous technology.66

Uber has also pursued a separate initiative called Uber Freight, which connects truck-owning drivers to shippers in similar fashion as its ride-hailing service.67 Several other startups have entered the freight space, including New-York based Transfix, which connects retailers, e-commerce companies, and other companies in need of freight services to truck fleets via an app.68 Startup ventures into the fragmented freight brokerage business indicate that freight logistics are on the verge of changing. Connecting freight needs to fleets is the first step in laying the groundwork for autonomous truck fleets.

The American Trucking Association (ATA) forecasts that trucking will continue to grow steadily through 2028, with an approximately 40% increase in freight tonnage by 2028.69 The growth of trucking demand combined with e-commerce growth will likely increase the numbers of trucks on our roads. ATA predicts that the number of Class 8 vehicles in operation could rise 19% by 2028,70 and e-commerce revenue increased 11% between 2015 and 2016, with the sector expected to be worth $3.5 trillion by 2023.71 While vehicle miles traveled for trucks will likely increase, personal vehicle miles traveled for shopping may decline. New distribution patterns will emerge as immediate deliveries of food, clothing, and other necessary items become commonplace.

Autonomous goods movement also opens up new possibilities for the look and capacity of delivery vehicles. Large trucks that are difficult to navigate and park on streets may be unnecessary if distribution patterns change and smaller trucks can make autonomous trips from neighborhood distribution centers.

If autonomous commercial vehicles prove successful and safe on the road, it will increase the public’s acceptance of autonomy in passenger mobility. This will be essential to addressing the equitable distribution of the technology’s benefits throughout society.

Another form of autonomous goods movement is the aerial drone, small aircraft that can be piloted remotely and eventually automated. Like autonomous vehicles, this advancement comes from the military application of the technology to provide real-time battlefield intelligence. Several companies, most notably Amazon, have begun experimenting with the drones as an alternative mode for deliveries. The advantages of this technology are clear; it would allow shippers to avoid congested roads or route goods more directly between origin and destinations in places with a limited roadway network. In the near-term these drones are likely to serve more rural, less accessible, areas. However, as the technology matures and regulators become more confident with its safety, aerial delivery drones could be introduced in more densely populated areas of the region. This could have the added benefit of eliminating truck trips once the payload capacity of the drones increase.

Deliveries by Aerial Drone

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Who built Google’s first self-driving car is now a trucker.


Ibid.

Passenger Mobility: The Shared Economy and Social Equity

Independent of the rise of autonomous vehicles, the automotive industry is changing. Auto ownership is in decline driven by generational preferences, new technologies that have given rise to one-way carsharing services, peer-to-peer carsharing, and on-demand TNCs and ridesharing/carpooling services. When compared to public transportation, owning a car is expensive, but sharing services make car use more affordable and readily available to those who don’t own cars. In certain situations, Uber’s rates are less than yellow cabs in NYC, and UBS predicts that moving forward, there will be further drops in pricing to increase competition. Between April and July 2016, Uber has cut prices in 7% of its markets. If fewer individuals are inclined to own cars, and more people are splitting rides through services like Uber Pool, there could be fewer cars on the road. However, statistics show that yellow cabs at the end of June 2017 were making nearly the same number of trips as Uber while using one fourth of the number of vehicles. TNCs are competitive partially because their pricing is mostly unregulated and they have no specific growth cap, allowing them to expand supply to meet the demand for their services.

Declining Auto Ownership

Between 2000 and 2014, New York State saw a 31% decrease in total private and commercial automobile registrations, New Jersey had a 22% decrease, and Connecticut had a 29% decrease. Nationwide, the proportion of licensed drivers at age 20-24 is down 15% between 1983 and 2014. The Transportation Sustainability Research Center (TSRC) at University of California, Berkeley, reports that about 1.3 million Americans enrolled in services in 2014, a 34% increase from 2013. In a study of the one-way service, car2go, TSRC researchers found that two to five percent of the car2go user population sold a vehicle due to the service in 2016. They estimate that the service prevented 10 to 29 million vehicle-miles-traveled annually per city, using assumptions of suppressed mileage. These statistics make planners hopeful that a shared vehicle economy could be the answer to traffic congestion and decreasing carbon emissions.

The growth in the sharing economy model for vehicles is buttressed by the millennial’s strong travel preferences for accessible urban environments and transportation. Millennials (born between 1980 and 1995) are a population that is 16 percent less likely to commute by car to work, three times more likely to use public transit, 23 percent less inclined to own a car, and more likely to use shared transportation services than Generation X. In the United States, 16 to 24 year olds who have a driver’s license dropped from 76 percent in 2000 to 71 percent in 2013. If millennials maintain low interest in driving and car ownership, a shared economy of AVs is more likely part of the near future.

Recent shifts to technologies such as electric vehicles and the rapid development of AVs suggest that all of these developments should act in unison to create the most optimized and energy efficient transportation network. McKinsey predicts that by 2030, one out of ten cars produced would be used as a shared “on-demand” vehicle. At this rate, one out of three cars in 2050 could be a shared vehicle. Shared vehicle and fully self-driving car market penetration timelines are therefore about matched.

74 Vehicle regulations keep the yellow cab fleet floating around 13,000 vehicles, while there are more than twice the number of Ubers at 28,000. Schneider, Todd. “Taxi, Uber, and Lyft Usage in New York City.” Accessed September 25, 2017. http://toddwschneider.com/posts/taxi-uber-lyft-usage-new-york-city.
75 FHWA, State Motor-Vehicle Registrations, 2000 & 2014
76 Sivak, Michael and Brandon Schoettle. “Recent Decreases in the Proportion of Persons with a Driver’s License across All Age Groups.” University of Michigan Transportation Research Institute, January 2016. http://www.umich.edu/~umtriswt/PDF/UMTRI-2016-4_Abstract_English.pdf
81 Ibid.
Ride Sharing in Metropolitan Areas

Metropolitan areas are the most mobility rich places in the nation, and the introduction of autonomous driving technology will further amplify their appeal. As of January 2015, TNCs, one-way, and peer-to-peer sharing services served 126 metropolitan areas in the U.S.82 These areas are important as testing grounds for new advancements in car technology because they are where more and more people are choosing to live. In the United States, metropolitan areas accounted for 76 percent of the total population in 1992 and have since grown to 83 percent in 2012.

BMI research group predicts a steady incline in urban population, paired with a drastic decrease in urban car density, signifying a more sweeping shift to autonomous vehicles in urban centers than suburbs.83 But the new technologies may encourage new ways of moving between cities and suburbs regionally. Although urban areas have many obstacles that complicate the introduction of autonomous vehicle technology, McKinsey predicts that AVs would most likely penetrate the market of dense high-income cities such as New York City first. City dwellers seek out the fastest and most cost effective way to commute, and few own cars. TNCs have already found success in New York City and the time and energy efficiencies of AV technology would amplify their appeal, helping New York meet environmental regulatory pressures concerning vehicle emissions.84

TNCs are currently not as affordable as public transit, but with the predicted cut of ride-on-demand fares, they could grow more competitive with bus service and fill the gaps in unserved neighborhoods. However, there is some evidence that TNC drivers deliberately avoid lower income neighborhoods for fear of safety or lack of rider demand—a problem that also affects other industries, such as yellow cabs. Others believe that the demand in unserved areas could incentivize driver attention.85 The elderly population could also be excluded from the shared economy since digital fluency and smartphone access in that group is low.

Impact on Public Transit and “Microtransit”

Autonomous vehicles have the potential to either supplant or complement public transit, depending in part on how regulators act and in part on the local context. In some urban areas now services like Lyft and Uber have experimented with fares and fare structures that are cost-competitive with transit, presumably to lure choice passengers taking short trips towards TNCs. Part of the decrease in bus ridership in New York City has been attributed to the rise of TNCs. But there is also great promise for TNCs to help transit agencies provide better service at lower cost to certain segments of the population (the elderly and disabled who currently use highly expensive and highly inefficient paratransit), and off-peak service in lower-ridership areas. These alternatives will be especially useful in suburban areas, where low density does not support robust bus services.

For instance, the residents of Pinellas County, Florida, voted against a tax increase to fund additional bus lines and a new light rail system. Instead, the Pinellas Suncoast Transit Authority (PSTA) decided to cut two bus lines, one with an average weekday ridership of 26 passengers,86 and subsidize Uber rides taken within the catchment areas of the eliminated routes. The idea was not to substitute bus ridership entirely, but rather bring riders to certain stops that could serve as connection points to major trunk-line bus routes. After a successful pilot period, PSTA decided to expand the partnership from its initial limited area to the entire county. They rebranded the service as “Direct Connect” and approved additional contracts with Lyft and United Taxi, so that residents can use any service for up to a $5 discount on rides to bus stations.87 PSTA has allocated $200,000 for the first year of the county-wide program, while just one of the routes it eliminated cost $160,000 per year.88 It was also awarded a federal grant of $300,000 to provide 23 free Uber or United Taxi rides per month for workers with late shifts that need to get home outside of bus service hours.89

Pinellas County’s program and a similar one with Lyft in Centennial, Colorado, illustrate a future of city partnerships with private TNCs. Although the success of these

pilots will rely on the low density of the area and affordability for the government. TNC-transit partnerships could become desirable for denser areas as well in the near future. These pilot programs could slowly supplant public transit services, or they could simply make it easier to connect to them. No subsidized programs yet exist that fund TNC rides to unlimited destinations, but Lyft claims it has helped over a dozen transit agencies to apply for federal grants that would pay for a portion of Lyft fares in situations where the services become incorporated into public transportation systems.90

On demand technology has fueled a microtransit startup trend, with companies such as Chariot, Bridj (now defunct), EasyMile, and others offering specialized route development based on user demand. Ford Smart Mobility, the autonomous vehicle and mobility innovation subsidiary of Ford, just recently acquired Chariot, an on-demand shuttle operating in Seattle, San Francisco, Austin, and New York City. Chariot operates both public routes and “enterprise commuter shuttles.”91 Chariot established itself first as a business-to-business transportation service for employees at suburban office campuses in San Francisco. The service does not necessarily require technology to implement, but it offers riders the comfort of reserving a seat and on-board wifi, and can offer usage data to employers in order to modify routes. Its other pursuit is crowdsourced transit routes for the public, where riders can suggest routes and must collect 50 votes to establish their route as a service. The route’s creator receives the title of “founder” and rides the route free for the first month. Currently, the private commuter routes in San Francisco extend from Oakland and San Francisco to Palo Alto and San Jose. Chariot’s public routes largely mimic SFMTA’s Muni service (Figure 2), and its daily ridership is estimated between three and four thousand, which does not come close to Muni’s 700,000 daily riders.92 Yet if the service becomes more popular, it could threaten demand for public transit and the agency’s revenue. Operations in New York City have just begun, with the first two suggested routes running from the Lower East Side to Midtown and Greenpoint to Downtown Brooklyn. While both service areas may have limited subway options, the Brooklyn route mimics the B62 bus. Both areas are also home to large young professional populations that are likely to try the service.

SFMTA’s Board of Directors will soon vote on a new law that would ban private transit from replicating Muni routes, require Chariot to share GPS and ridership data with the agency, and mandate Private Transportation Vehicle (PTV) permits for its fleet. Jitneys had been regulated in

92 Jonlin, Alexander. Phone interview by Allison Henry. Transportation Analyst, Sustainable Streets Planning Division, SFMTA (September 27, 2017).
San Francisco until 2011, when the legislation was discontinued due to a dwindling number of jitney operators. After many residents and Muni bus drivers complained of Chariot vehicles double parking and stopping at Muni bus stops, SFMTA decided to bring back PTV regulations. The agency has already designated yellow and white loading zones for passenger and commercial loading and unloading, which Chariot is allowed to use. Through SFMTA’s Color Curb program,92 the company could apply for additional loading zones in popular stop locations with the consent of business owners located near the curb. SFMTA has been working with Chariot on the new piece of legislation, which will allow the company to grandfather in existing routes yet wins the agency important data about the ridership and routing of PTVs.94 In New York City, Chariot vehicles are subject to the same regulations as all other black cars and must submit origin and destination data. No separate regulatory category is currently under consideration.95

Before Boston-based startup Bridj was dismantled after negotiations with Toyota collapsed,96 CEO Matthew George had big plans to provide a more regulated approach to TNC-transit partnerships. It launched in Kansas City and hoped to offer a middle ground between traditional public transit and the “Ayn Randian free market free-for-all” that lacks labor and patron legal protections.97 Bridj’s drivers were union members hired by the transit authority. The company made its profit off of the app technology and operational service, while the transit authority in Kansas City staffs the buses and set fares of $1.50. Despite the convenience of the service taking passengers exactly where they wanted to go, only 1,480 out of 2 million Kansas City residents rode in a Bridj van over the course of its six month pilot.98

EasyMile is an autonomous shuttle company based in France that has teamed up with cities across the globe including Helsinki, Tallinn, Dubai,99 and Concord, California,100 to run pilot versions of a flexible transit system that would allow 12 shuttles to operate based on user demand. “Metro mode” operates as a traditional light rail system, stopping at all designated stations; “bus mode” stops at stations on request; and “on demand mode” operates like a ridesharing service, picking up passengers at requested locations.102 Cities may find EasyMile’s strategy appealing, because it does not seek to deter demand away from their existing transit services. The vehicle size is slightly larger than Uber for increased passenger capacity and wheelchair accommodation, yet smaller and easier to maneuver than large buses currently in use. Summoning buttons at stations could make the service more accessible to the elderly and those who do not own smartphones.

These services are still in their infancy and their business models are still unproven. While governments should by all means explore pilot programs with these companies, they should conduct due diligence and ensure that their plans take the financial conditions of their partners into account. This is especially important when thinking about fare regulation and complete replacement of public service by a private operator. Whatever the particulars of microtransit service, the recent popularity of the HOV on demand shuttle service concept demonstrates the potential for technology to fill a gap in existing transit services. The affordability of such services will initially depend on subsidies from transit agencies and venture capital, but with the rollout of AV technology it would increase significantly. While microtransit will initially work to address existing demand in transit deserts, it has the potential to supplant...
public transit and impact the bottom line of public transit providers. Transit agencies and government officials should be aware of this possibility and in the future work to coordinate routes between public and private transportation operators – perhaps requiring greater regulatory oversight. Public agencies should also incorporate on-demand technology into their transit offering to improve efficiency, lower costs and provide more direct service to riders along lower-demand routes.

**Electric, Autonomous & Shared: The Convergence of Vehicle Technologies**

AVs and urban-based shared economies are well positioned to adopt electric propulsion technologies. Declining auto ownership in urban areas combined with the high value of land in cities – evident in Manhattan’s swiftly disappearing gas stations – makes this transition almost inevitable. Manhattan lost 33% of its gas stations from 2004 to 2014, with fewer than 8 remaining below 96th street today. Many of these gas stations have been bought by luxury apartment building developers. Nationally, there has been a 25% decline of fueling stations between 1994 and 2013.\(^{103}\)

The future of gasoline fueled fleets and the revenues collected to support infrastructure are critical areas that transit planners must address. Some foresee greater use of EVs in the future and most agree gas tax revenues, the main source of funding for highways and public transit, will continue to decline as fuel efficiency increases. This is particularly relevant to New York City, which has steadily pushed out its gas stations and encouraged the adoption of more fuel efficient vehicles. Mileage-based user fees (MBUFs) are one solution to the funding conundrum. This system would track the vehicle-miles traveled (VMT) for each registered vehicle in order to calculate the appropriate tax, which could be based on the time of day or level of congestion. MBUF and AV systems have similar deployment strategies and timelines, making them natural partners. Precise location information may be collected about where and when people drive in order to calculate appropriate tolls or even promise that tax and tolling charges will go directly to the betterment of the roads that the vehicle uses. These tracking principles could also be applied as the technology transitions to a shared ownership model, incorporating fees into individual transit user’s profiles. In an intermodal system, a streamlined city-wide transit account could serve as payment for rail, AV taxi, and personalized [mileage/automobile travel] taxes appropriate to the individual’s travel patterns.

The shared economy, MBUF tax determination, conversion from gasoline to electric powered vehicles, and autonomous technologies are interconnected and forecasted to advance along similar timelines. As indicated by Uber’s pilot program in Pittsburgh using autonomous vehicles provided by Volvo, the introduction of fully autonomous vehicles to the public may first occur through ridesharing services. The future of TNCs is surely autonomous, but self-driving technology may take over above and below ground, across transportation modes as all vehicles adapt to the mechanical change. Autonomous shuttles could replace BRT and light rail, driverless trucks will form autonomous platoons of freight, driverless garbage trucks could communicate with waste receptacle drones, and modern train control will automate NYC’s aging subway system.

What AVs Could Mean for the Region’s Built Environment

At first, autonomous vehicles may bring a jumbled mess – particularly in New York City where autonomous TNCs could continue to grow and compete for space with yellow cabs, buses and the increasing number of delivery trucks on the city’s narrow streets. In such a dense landscape, on-demand driverless cars could lead to a reduction in private car ownership, but could also compete with public transit as has already been documented. In suburbs and rural areas, driverless vehicles may have a far greater impact – increasing mobility for many but likely also encouraging further sprawl. The ride share and yellow cab industries will transform – they may even combine into one. Autonomous vehicles will likely change the role of the automobile and provide more than just a means for personal transportation, acting as a delivery service and even a mobile office. The introduction of fully autonomous vehicles to the tri-state area will come with its challenges, consequences, and benefits. City planners must understand the changes to come and plan accordingly to achieve the greatest possible outcome for urban citizens.

New York City

Recent history has shown that New York City has been the target of many recent mobility innovations due to its large and concentrated population. On-demand services have clustered in the city, with three out of four TNC vehicles operating in the city serving Manhattan. While this means that residents are given more choice and are early adopters of the latest technologies and trends, the impacts on the city have not all been positive. For example, TNCs have led to increased congestion and siphoned riders off the city’s extensive public transportation – diverting bus riders throughout the day and subway riders in the evenings and weekends. Technically speaking, AVs would be initially easier to implement in suburban areas because of the relatively less complex operating environment, fewer intersections, pedestrians and other obstacles that make navigating a dense city more of a chore. However, because of the large market and the fact that the TNCs themselves are driving the innovation to lower their costs and will be early adopters, New York City and the surrounding inner core will likely come first.

**Streets**

Street space in New York City is a finite and precious commodity. During the advent of the first automobile age, spanning roughly 1908 to 1939, the city’s streets were transformed from mixed-use spaces that supported all different types of activities to signalized automobile thoroughfares that pushed pedestrians and other activities to its edges. Sidewalks and other pedestrian plazas were further cut back over the decades so that roads could be widened and lanes added to accommodate even more automobile traffic. These trends continued through the 1980’s until Manhattan’s West Side Highway was transformed from an elevated highway to a boulevard accompanied by a bike path in the 1990s that started a new trend of repurposing street space for people and other activities. Today, many streets have been narrowed to accommodate wider sidewalks or bike lanes or completely transformed into pedestrian plazas. During the Bloomberg administration, NYCDOT added almost 400 miles of bike lanes and 60 plazas across the city in addition to launching the Citibike program in 2013. This effort has had continued success, increasing the value of properties and the attractiveness of New York City as a place to live and visit.

There are 6,000 miles of streets today in New York City and over 77% of that space is used for automobiles. RPA’s recommendations for streets in *A Region Transformed*, RPA’s fourth plan for the New York-New Jersey-Connecticut metropolitan area, will lay out an aggressive series of interventions to accelerate the measures that are already

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106 Bruce Schaller’s report studying the growth of TNCs in New York City found that most TNC mileage growth has occurred in the evenings and weekends, and weekend subway ridership declined in 2016. Schaller (2017), p 14.  
107 There were a few attempts in the 1980’s during the Koch administration to create bike paths and reclaim space for pedestrians, but these actions were very limited and most ended in failure. The most infamous example was the installation and subsequent removal of a protected bike lane along 6th and 7th Avenues.  
108 The pedestrian mall on Fulton Street from Water Street to South Street was actually the earliest example of this, but it was an isolated intervention that was more of a fad from the era of festival marketplaces – outdoor malls in urban areas that have met with mixed success.  
underway to give back more space to pedestrians and add capacity to by far the largest transportation mode - walking - in the city. The congestion in the central business district (CBD) is untenable and with the addition of over a million people and over 800,000 jobs in New York City by 2040 as projected by RPA, substantially more space will be needed to accommodate these crowds. Adding to this growth will be the rise in tourism, which is anticipated to reach new heights over the next five years – with forecasted annual tourism reaching 67 million people by 2021.10

In the future, dozens of streets could be taken off-line for cars as new open space for people is extended throughout the city. Sidewalks could be widened, two-way bike paths installed and remaining traffic lanes prioritized for public transit and the efficient movement of goods. Some sections of the city will also have shared streets that will no longer have curbs, allowing all users to comeingle in a slow-speed environment, made possible by geofencing technology that will limit movement of vehicles into public spaces, based on the time of day.

That means the City will need appropriate regulation and pricing to curb the number of AVs competing for limited road and curb space. Priority and lower pricing should be given to vehicles with higher occupancy rates than those that essentially perpetuate a more traditional for-hire-vehicle model. Some researchers have suggested that initially full automation combined with on-demand service could lower the number of vehicles on the road. A study conducted at Columbia University, estimated that for every 50,000+ taxis and livery cars in operation, less than 9,000 TNC-AVs could replace them.11

More curb space will need to be designated to enable efficient drop-offs and pick-ups so vehicles do not impede the flow in the remaining mixed-traffic lanes. Over the next decade this curb space should be physically distinguished with signage but overtime it could be virtually assigned to various users (trucks, public transit and private AVs) based on time of day or need. However, there are still many unknowns. One of them is how much AVs will resemble for-hire and private vehicles (automobiles, SUVs and vans) that are on the street today or whether they will morph into some new form. These new forms could be extensions of the home, bedrooms and living rooms on wheels, or the office, which while very different, should still be treated as a luxury and given limited access. However, they might also start to blur the lines between what we define as public transit, providing greater flexibility, frequency and coverage in lower demand corridors or during lower demand periods. These services could also be owned and/or operated by the public, complementing public transportation. In this scenario it might be beneficial to provision more street space for these services and limit the barriers to their introduction.

**Parking**

This is one area where AVs could assist in freeing up street space and land for redevelopment. Parked vehicles occupy a tremendous amount of street space. On-street parking alone consumes an estimated 24 square miles of land in New York City.12 Most streets in the city have at least one lane designated along the curb for parking and much of it is free of charge. Street parking takes up space that could be used for moving traffic, including people on bikes, expanding sidewalks to improve pedestrian flow and experience or other services like bike parking or parklets. It also results in the dreaded double parking, where short-term parking that’s needed for deliveries or services is insufficient because much of the curb is used for longer-term residential or commuter parking. Double-parking consumes travel lanes, impeding the flow of traffic. Eliminating on-street parking and reducing the demand in adjacent off-street facilities in urban centers could be accomplished by an AV in a handful of ways:

- Dropping off passengers at their destination and then returning to its origin (home base), awaiting a return call (or a pre-determined time) to pick-up the same rider(s). This approach does not eliminate the need for

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12 RPA calculation using DOITT street center line data. Parks removed, each street assumed to include two eight-foot wide parking lanes.
all parking in residential areas in the city, assuming many of these trips will be intra-city, but would lessen parking demand in commercial corridors.

- Circulating empty or going to a designated staging area outside or at perimeter of a city. This would have the benefit of eliminating parking but would result in greater VMT and congestion. It would still require garages or lots to store the vehicles but these could be placed in less desirable areas thus opening up parking facilities closer in for redevelopment. Should there be a restriction on single-occupancy-vehicles or zero-occupancy AVs? How can pricing disincentivize people from sending their cars to run an errand down the block?

- Being shared and staying in motion. The ideal scenario would be to have the vehicle shared and never park except for maintenance or to charge its batteries. However, the shared economy is unlikely to be for everyone, especially for those with the means to afford their own private automobile or those who use one frequently.

There are many paths the AV might take once they’re in operation. They have the potential to dramatically change the demand for parking and allow the city to substantially reduce its supply, yet other forms of operation would still require the city to maintain a reduced supply of on-street and/or off-street parking and could also produce more VMT and congestion.

Why Regulation? Shouldn’t Pricing Be Enough?

The demand for travel has long been proven to be sensitive to pricing. For example, the higher tolls are raised on a bridge, the greater the reduction in traffic volumes. Non-work or discretionary trips are also more sensitive to pricing than work trips, especially if travel time competitive transportation alternatives do not exist. In the past, it was assumed that, aside from the very wealthy that do not drive themselves, time spent commuting in an automobile was unproductive or lost time. Driving combined with paying tolls and parking fees was a considerable cost to the privilege of a private and more express form of mobility. These costs combined with increasing congestion, which negated much of the travel time benefits, were what pushed more and more commuters to abandon driving and take public transit. AVs have the potential to upend this calculus in one major way – they will allow riders to be productive by taking away the need for them to operate the vehicle. This, along with the new forms that AVs might take, could allow users to sleep in bed as they commute or sit at their desk and participate in virtual meetings. If the AV provides these productive (or resting) spaces, it could lower the sensitivity to congestion and pricing. These are the reasons commuters give as to why they shift to public transit. They can use the commute to close their eyes, read a paper or work on their laptop. For example, if your commute took twice as long but you were able to sleep the entire way in a bed or use the time to catchup on your emails, would you pay a little extra? Since these options do not yet exist it is impossible to determine how high the pricing would have to go in order to dampen demand.

There is a possibility that pricing alone will not be enough. In this case some form of regulation might also be needed to ration the street space in order to reduce AV and manually operated vehicle congestion and their impact on cities. Empty personal autonomous vehicles are particularly concerning because there is no time cost for the driver and he or she would also gain the time that would traditionally be spent parking. One option, combined with pricing, might be to cap the number of single-occupancy vehicles allowed to enter the CBD. It will be important that public transportation in all its forms is able to provide equitable access to all income groups and that lower occupancy and private cars provide the cross subsidy to fund these improvements. Gridlock in the future could consist of a never ending stream of AVs and manually-operated vehicles flowing through the city, with more streets with levels of congestion like Midtown or major arterials (Queens Boulevard or Fordham Road), something that most city dwellers would consider a nightmare scenario.

Transit

Without public transportation, the New York City would not function. Most travel today in the City is accomplished on public transportation and all include a walk trip at some point during the journey. Over 2.5 billion trips per year are completed on the city’s buses and subways.113 By comparison, taxis, black cars and TNCs only serve about 480 million annual riders.114 While these numbers are growing, they are still only a fraction of what public transportation does. For-hire-vehicles are likely to be the first autonomous surface transportation service. The question remains whether these services become public transit? Will they complement or compete with the existing public transportation?

To understand the dynamic between public transportation and cars one can draw lessons from history where similar parallels exist between the early days of transportation and the disruptiveness of TNCs and AVs today. At the turn of the last century, circa 1900, transportation was mostly a private provisioned service. Companies were sprouting up everywhere to offer elevated streetcars and eventually subway service to New Yorkers. The purpose of these companies was not to provide transportation but to redevelop the land along the routes, with transportation as a means of making these places accessible and attractive to potential buyers and renters. Over time many of these services were no longer profitable and were either eliminated or taken over by the public sector.

TNCs are operating on a similar but different model today. They were started and have been supported by venture capital. They are technology companies whose primary trade is to develop new predictive pricing and logistical algorithms. They own the application that manages the transaction between the drivers and riders, but most do not own the vehicles or provide liability insurance or employee benefits. Even without the overhead, TNCs are still not producing a profit through their operations, with some losing billions of dollars annually.115 For example, it has been reported that Uber subsidizes up to 60% of its rides.116 If the venture capital was to dry up or if the companies go public and cannot cover their losses or provide a dividend to their shareholders, there are real concerns that history could repeat itself. Many of these companies could go out of business or end up being taken over by the public sector. The jury is still out on the sustainability of this model, as private transportation services (e.g. the airline industry) continually struggle to make a profit partially due to their substantial capital outlays.117 To date, TNCs have avoided some of these costs because they do not own fleets of vehicles, but AVs are changing this paradigm. As Uber and others are currently spending considerable sums of money to develop the technology and pilot their own AVs, it is important that planners and policymakers be cognizant of this history.

The city should not become captive to these services and in the process diminish its own public transportation system. This is especially true in places where fixed-route transit is supported by density that could be further improved.

One future could see TNC-AVs falling under public sector ownership and operation, particularly if they diminished public transit ridership to the point that mobility options were impaired. They could then be coordinated in a manner that complemented the desired transportation policy outcomes of New York City. Alternatively, the City could franchise out the operation of the public fleet to a private operator, while also setting the rules and service performance as part of the contract.

In the near-term TNC-AV could complement the transit system by providing coverage for planned or unplanned public transit service disruptions during the weekends and evenings. They could also provide paratransit services in some cases at a lower cost than the MTA, as discussed by the Citizens Budget Commission.118 The MTA should explore both opportunities and the fare subsidies that would be required. Consideration would also need to be made for passengers who would require some additional form of assistance getting in and out of the vehicles.

Further out, as discussed earlier, AV could take on new forms entirely, including microtransit. Removing the operator on buses would dramatically lower the costs of operating the service, as labor makes up 25% of the total operational cost of buses in New York City.119 These high labor costs are one of the main reasons that buses have such a low operating farebox recovery ratio and require a high public subsidy – 35% compared to 61% for the subway.120 It would allow the MTA to lower its operating costs and also increase the frequency of service for higher demand routes. The agency could also use smaller on-demand vehicles to serve lower-demand routes and with some of the cost savings, reallocate vehicles to add higher capacity and frequency of service on major routes in the evenings and overnight – thereby increasing the overall span of transit service. New technologies will allow transit agencies to

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113 MTA, 2016.
114 TNCs, black cars, and yellow cabs take 15% of the share of commuters, not including commuters using personal vehicles, paratransit, biking, or walking. Schaller (2017), p. 31.
117 They are also unprofitable because of how they price their services at a discount to attract customers. http://www.nakedcapitalism.com/2016/11/can-uber-ever-deliver-part-one-understanding-ubers-bleak-operating-economics.html
119 NTD, 2015.
think beyond existing vehicle fleets and imagine new types of vehicles to accommodate a variety of user needs. Surface transit will also consist of an array of vehicle sizes to support various tasks, and if those vehicles are operated by transit agencies, they can be coordinated to benefit the public.

It is important that TNC-AVs evolve without jeopardizing the public transportation system. As RPA’s research for the Fourth Regional Plan indicates, the MTA needs to make a wide array of investments in the subway system in order to retain and attract additional ridership New York City’s Taxi and Limousine Commission (TLC) has been successful in outlining comprehensive safety and consumer protection regulations since 2014, but there are limited economic regulation or controls in place for TNCs. TLC’s biggest accomplishments to date include mandates for driver screenings and education, an in-app tipping option, and consumer protections including an itemized receipt of service, fare estimate, and notification of the driver’s name and license plate number. Many of these regulations have been embraced by consumers and TNCs’ marketing teams, as they rolled out “up front pricing” nationwide. Recent rules to prevent fatigued driving have expanded trip reporting requirements so NYC-registered TNCs must publicly disclose origin and destination trip data, and accessibility rules are currently on the table.121

History has proven that limited regulation results in less mobility and greater inequity for residents. The recent practices of the private companies have furthered these concerns. For example, Uber’s recent spate of incidents involving all three of its self-driving car pilots has raised serious questions about whether these services could really serve as a substitute to public transportation. The company was initially banned from operating in San Francisco, California, after an incident with the California DMV over failure to comply with self-driving vehicle permit requirements where it was found to have intentionally tried to deceive the authority. In Tempe, Arizona, Uber was allowed to operate its AVs restriction-free; however, an engineer was not able to interfere quickly enough and one of its AVs crashed.122 In Pittsburgh, Uber was originally welcomed by Mayor Bill Peduto; He later publicly criticized the company for not holding up its promises to provide jobs in the community that holds its autonomous testing track, as well as charging for rides that it claimed would be free.123

New York City should proceed with caution after learning from these missteps. It will be critical for the TLC and the MTA to work together to regulate and shape this industry as they leverage the benefits that automation will afford and control the negative externalities. They must also ensure that there is cross-subsidy and/or equity in pricing. To either provide affordable access to these services or good public transportation alternatives for lower income New Yorkers, the latter would be preferable.

**Data & Integrated Mobility Services**

Regulators should be cautious about partnerships with private companies, but must also work with industry to set the stage for more fluid sharing of data to increase transparency and foster the ability for the public to plan for these services. AVs will be constantly collecting information about the environments in which they operate. This data, if shared with governments, will be invaluable for understanding travel behavior, enabling transit agencies to better plan public transit services. It will provide insights for the future of regulating curbside commercial and passenger drop-off zones as well as safety data for the most dangerous intersections. Deputy Mayor Alicia Glen joined the Sharing Cities Summit to collaborate with other global cities on how to regulate new disruptive technology companies like TNCs. She has stated that she wants these companies to succeed while “[understanding] that we have a legitimate interest in regulating them.”

Transportation planning may become increasingly oriented around the concept of “mobility as a service,” which converges several modes of transport services into a single, accessible, on-demand mobility service. Finland has been a leader in this effort and passed the Act on Transport Services in April 2017 to promote user-oriented and competition-friendly transportation services. The Act contains provisions on the “interoperability of ticketing and payment systems” and mandates that TNCs must provide essential data related to mobility services.124 Additionally, Helsinki’s Ministry of Transport and Communications has partnered with a startup called Maas global to launch Whim, an app that functions as a trip planner for both public transit and private trip services and offers several multi-modal payment packages for combinations of city-wide public transport, taxi use, car rental, and national public transport.125 In an autonomous vehicle future, integrated payment systems will make it easier and more user-friendly for passengers to plan multi-modal trips involving public transit. If the con-

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The convenience of scheduling and payment in ride-hailing apps is matched by transit services, public transit will remain a desirable option for urban dwellers.

The Suburbs

The region’s suburbs have the potential of benefiting immensely from the introduction of AVs. This should come as no surprise as the technology, along with on-demand services, has been shepherded by Silicon Valley, which is striving to solve its own suburban sprawl mobility problem, and the automobile industry. However, the technology also has the potential of increasing the attractiveness of suburbs resulting in even more congestion and sprawl development.

Many post-WWII suburbs were built around the automobile and have not been designed for walking or biking. In many cases doing so is downright dangerous. Land uses are segregated with residential areas clustered together and away from commercial districts; many of these commercial areas are located on high traffic roadways that have not been designed to accommodate pedestrians, cyclists or people walking from bus stops. As the baby boomer generation grows older and unable to operate an automobile, more of the region’s population will lose mobility. They will rely on their family and friends to get around, similar to younger children who must be driven by their parents to all activities. AVs have the potential to address these issues, freeing up parents’ time for more productive tasks and increasing the mobility for young and old alike. This would fill a huge mobility gap in the suburbs and also make them more attractive for families and the elderly. However, this

Many suburban households have no access to a car

Figure 3: Percent of Households with No Vehicle in the Region
Source: American Community Survey 2015
change could disincentivize denser development in the suburbs and discourage more active modes of transportation like biking and walking. The public health impacts could be severe as old and young eschew a more active lifestyle for convenience and speed.

There will also likely be a greater resistance to sharing a vehicle in the suburbs compared to the city. City dwellers are accustomed to public transit and shared spaces, whereas most suburbanites commute alone in their private automobiles. It is important to recognize how attached Americans are to their automobiles; they customize them and use them as extensions of their personal living spaces. In a shared vehicle environment they would need to take what they have with them every time they exit the vehicle or just leave their personal items at home. As long as it’s affordable, many suburbanites will still desire their own private vehicle.

**Highways and Arterials**

The highway system acts as the express lanes that traverse the suburbs and provide quick connections between various activity centers. They are also critical corridors for the movement of goods in the region. The arterials and collector roadways connect the neighborhoods to local commercial/retail areas and to the highway network. Many of these collectors are congested as more and more developments have sprung along them over the past 50 years and the demand for goods and services has increased. Highways in the suburbs also suffer from congestion, some more extreme than others. Parts of the region, like Long Island or Connecticut have a serious chronic congestion problem, whereas New Jersey’s congestion, while bad, is less so because of the excessive number of lane miles it has.

Federal Highway Administration has estimated that about 25% of traffic congestion is due to traffic accidents (FHWA). Fully functioning and safe AV could reduce congestion and traffic accidents, thereby increasing capacity, but this will depend on full AV market penetration. Some studies have estimated that this could increase roadway capacity by 25-35%, while others have suggested even higher numbers. The Eno Center for Transportation estimated that at 90% market penetration, freeway congestion could fall by as much as 60%. However, this estimate assumes that 115 million AVs will be on the road, and only 10% of this fleet will be shared. Given the 262 million vehicles already registered in the U.S., and the likelihood of human driven cars remaining on the road for some time, the congestion benefit prediction seems aggressive. Yet, many of these same studies have also shown that VMT will increase due to induced travel (e.g. those that did or could not make the work or non-work trips before, such as disabled, younger or elderly populations), consuming much of the added capacity. This all raises the critical need to price roadway links accordingly to ensure that traffic is free flowing and congestion doesn’t worsen as demand rises, which will be discussed further in *A Region Transformed*, RPA’s fourth plan for the New York-New Jersey-Connecticut metropolitan area.

As mentioned earlier, TNC-AVs are well suited for the suburban environment due to the dispersed origin and destination patterns that prevent dense mixed-use corridors from developing, a requirement for a fixed-guideway transit service. The biggest obstacle to on-demand services today is the cost of provisioning a sufficient number of vehicles in less dense areas to support a quick response (5-10 minutes) to ride requests.

As automation replaces drivers, operating costs will decline, making first-and-last-mile solutions even more affordable and feasible in less dense places. Yet, there will likely be a need for subsidy, and the cost of that subsidy weighed against conventional fixed-guideway public transportation or a greater number of private automobiles will need to be evaluated on a community by community basis. Larger municipalities might also choose to own and operate their own fleet of TNC-AV.

One additional safety benefit of AVs would be “geofencing” or the ability to virtually cordon off streets by time of day or set speed restrictions without the need for physical barriers or traffic enforcement agents. This would be extremely beneficial for communities, creating safe places for children to bike and play and enforce speed limits around major events and schools.

**Parking**

The suburbs are often characterized by their endless parking lots. Free parking is abundant and is considered an essential service like sewer and water. Similar to the city, AVs have the potential to substantially reduce the need for parking and/or enable a shift in how it is designed. Extensive areas for pick-ups and drop-offs will still be required, but storage could be eliminated or shifted to other areas allowing for adjoining infill developments that could create a more walkable and dense environment. Some of these AVs could be shared, which would eliminate the need for storage, but many will still be privately owned and operated and could either return to their origin or a perimeter lot. Many of these massive impervious surfaces with hundreds of parking spaces could be redeveloped as mixed-use communities or open space. Additionally, parking lots at major transit facilities would be reconfigured for drop-off and pick-ups and the surrounding surplus land redeveloped. At the 353 regional rail stations in the region, RPA has estimated that 7,519 acres of impervious parking surfaces could be reconfigured for drop-off and pick-ups and the surrounding surplus land redeveloped.
rounding surplus land redeveloped. Much of this land could become mixed-income housing, which will be discussed further in A Region Transformed.

Some places are already providing subsidies to support more services in their communities, such as Summit, New Jersey, whose train station has an average of 3,933 weekday riders but just 966 parking spots. Instead of building a new parking lot for $10 million dollars, the municipality chose to subsidize Uber trips at a cost of only $167,000 annually. The pilot, which began in October 2016 with 100 users, cost Summit residents $2 each way to participate and was limited to one trip within commuting hours from within Summit to the train station and one trip from the train station to another location in Summit per day. For the first six months of the pilot, utilization rates had averaged around 30%, meaning a majority of the 4,000 ride per month allotment went unused. Since most people use the pilot inconsistently only a few days per week and sometimes going a full week without using it, the City of Summit took an additional 50 people off of the program’s waitlist in April to see if they could increase utilization rates. Instead, the rates have continued to decline in June, possibly due to summer vacations.

![Figure 4: Summit Pilot Utilization Rates, 2016-2017](image)

Source: City of Summit, New Jersey
Note: In April 2017, the pilot expanded from 100 to 150 participants.

Even with its slow start, the city still plans to continue the pilot, which must overcome several challenges to increase its rate of adoption. First, the service lacks flexibility for households with children who may want to use a car after commuting to do family related activities and run errands. The cost of compact car ownership amounts to approximately $18 per day, making the Uber pilot more cost effective for individuals who do not own cars. However, most households in Summit own at least two cars, and only 5% do not own a car. The service may not offer enough of a convenience or offer a sufficient cost incentive to convert the driving habits of most households. In order to incentivize higher utilization, the cost of parking may need to be further increased, and the discount of buying an annual parking pass may need to be reduced.

In an autonomous vehicle future, assuming a cultural shift away from private auto ownership, rides would need to be planned for all 4,000 weekday train trips from Summit, unless some riders walk or bike to the station. The cost of running this service combined with the opportunity cost of the parcel of land intended for a parking garage would need to be compared in order to understand the financial feasibility of running such a program. As a first step, Summit and other municipalities planning to offer subsidies for TNC services should conduct a survey to find how commuters without parking passes currently get to the train station. A future in which the majority of commuters use an on-demand service would require higher occupancy vehicles to mitigate surface traffic impacts, requiring an understanding of the willingness of residents to travel in shared vehicles.

The Uber pilot in Summit, NJ, is a trailblazer in addressing the challenges of the shift away from vehicle ownership. For now, it offers a feasible way of managing some parking demand, but in order to expand the program, it will need to evolve.

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133 American Community Survey, 2015.
Autonomous vehicles are coming and it is in the New York region’s best interests to prepare for them. Public officials and agencies should not stand idly by and let emerging technologies dictate how the city evolves. Instead they should be proactive to ensure the best possible outcomes for those that live and work in the region by learning from the mistakes of the automobile age.

In cities, there must be a balance between surface vehicles and pedestrians and other non-motorized uses of street space. In suburbs, new forms of active mobility must be encouraged along with denser development around transit and the elimination of parking on the vast acres of impervious surfaces. AVs and other technologies can support these outcomes but only if their implementation is guided by smart policies that allow for innovations but also control for negative externalities, such as sprawl, congestion, and reduced public transportation ridership.
Regional Plan Association is an independent, not-for-profit civic organization that develops and promotes ideas to improve the economic health, environmental resiliency and quality of life of the New York metropolitan area. We conduct research on transportation, land use, housing, good governance and the environment. We advise cities, communities and public agencies. And we advocate for change that will contribute to the prosperity of all residents of the region. Since the 1920s, RPA has produced three landmark plans for the region and is working on a fourth plan due out in 2017. For more information, please visit, www.rpa.org.

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