PLAN FORWARD

Microtransit, Micromobility & Autonomous Vehicles

Executive Summary

Alternative forms of transportation, such as microtransit, micromobility, and autonomous vehicles (AVs), are emerging as vital components of the broader transportation network, providing flexible, on-demand options that complement traditional public transportation systems. These modes of transportation are different from conventional single occupancy vehicles (SOV); often more sustainable, cost-effective, and efficient. These services are effective in addressing first/ last mile challenges, where users face difficulties accessing main public transportation routes, or connecting to destinations under five miles.

In Fairfax County, microtransit, micromobility, and autonomous vehicles (AVs) offer significant potential to enhance the overall transportation network access and connectivity and, influence the way people move. Microtransit services provide flexible, on-demand routes in areas with lower ridership or irregular demand, helping to bridge the gaps in public transportation and reduce dependence on single occupancy vehicle (SOV) use. Microtransit utilizes advancements in mobile technology and GPS, making transportation services more efficient and user-friendly. Micromobility solutions, such as e-scooters and bike-sharing, support the transit network by integrating with public transportation and shared mobility services to solve last-mile challenges. Capital Bikeshare is already demonstrating success in Fairfax County by providing a sustainable, accessible, and affordable transportation option that complements existing public transit systems and connects communities across the region. AVs present an opportunity to address traffic congestion, improve road safety, and provide equitable transportation options for individuals unable to drive, including the elderly and people with disabilities. As these new technologies continue to develop, they may impact the transportation decisions of employees, community members, and visitors, increasing accessibility to different areas of the region.

The purpose of this paper is to explore Comprehensive Plan (“Plan”) policies, along with other regulations and programs, to support microtransit, micromobility, and AVs within Fairfax County. This paper addresses the evolving role, including challenges and opportunities, of emerging trends and technologies, along with potential regulatory, programmatic and Plan policies. These emerging technologies could significantly contribute to Fairfax County's goals of improving transportation efficiency, reducing environmental impact, and expanding mobility access across the region, particularly in underserved or suburban areas.

Background & Implementation

Microtransit is a flexible, on demand, dynamic service that operates similarly to traditional public transportation, but with more adaptability to individual needs, using smaller vehicles including, but not limited to, vans, shuttles, or minibuses. While ride-hailing (Uber, Lyft) provides a similar function, accessibility concerns around ride-hailing include limited availability of wheelchair-accessible vehicles (WAVs) and inconsistent service for individuals with disabilities. Microtransit often specifically incorporates dedicated vehicles and pre-planned routes designed to accommodate diverse mobility needs more inclusively.

Micromobility refers to sustainable, short-distance travel options, providing a viable alternative where the transportation network is inadequate. Micromobility provides low-speed transportation options designed for shorter distances using vehicles that include, but are not limited to, bicycles, e-bikes, scooters, and e-scooters. These flexible and convenient services are often referred to as a first mile/last mile solution, due to the popularity of use in urban areas to connect users to their destination and are often only used for trips that are less than five miles.

Use of autonomous vehicles, or driverless cars, may reduce the number of low-occupancy vehicle trips during peak congestion periods, supporting and encouraging use of public transportation. This occurs because AV use enables more efficient ridesharing and carpooling options, as autonomous systems can optimize routing to pick up and drop off multiple passengers heading in similar directions. Additionally, AVs can also serve as first mile/last mile connectors, seamlessly integrating with public transportation by transporting riders to transit station areas, reducing the reliance on single-occupancy vehicles and enhancing the overall convenience and appeal of public transit systems. This synergy can increase utilization of sustainable transportation modes.

The Role in the Modern Transportation Ecosystem

Microtransit, micromobility, AVs, and other similar services are a reaction to the growing need for flexible, reliable, and more personalized transportation options. While traditional public transportation systems often provide fixed routes, microtransit fill the gap for shorter, demand-responsive trips. The evolution of digital technologies, including ride-hailing platforms, GPS, and real-time data, has facilitated the rise of alternative transportation options. Micromobility, encompassing bikes and e-scooters, has grown in parallel, driven by urbanization, environmental concerns, and changing commuter preferences.

As the proliferation of AVs increases, and the underlying technology becomes more sophisticated, understanding the intended and unintended impacts of automation on land use, transportation patterns, safety, racial equity, environmental sustainability, cybersecurity, and the regional and national economy will be critical to avoiding negative impacts to community members. The County also has an opportunity to harness the potential positive impacts of AVs through a transparent, adaptable, and comprehensive policy approach. While some aspects of these transportation trends can be shaped through planning and land development, such as designing infrastructure for AVs or creating bicycle lanes, others rely more on programmatic efforts, including service operations, technology deployment, and regulatory frameworks that are outside the Comprehensive Plan.

Benefits of Alternative Transportation

The mobile applications and GPS technology integrated into Microtransit and AV systems enables alternative transportation methods that are flexible and efficient. Integrated GPS tracking and mobile platforms, microtransit provide real-time data on vehicle locations, route optimization, and travel-demand patterns, streamlining the user's experience through accessible mobile applications that allow users to book rides, track vehicles, and receive real-time updates. Dynamic routing algorithms use real-time data to optimize routes based on demand, reducing wait times and improving service efficiency. The data collected from these applications has contributed to innovative solutions in urban mobility, improving traffic flow and supporting future planning efforts, such as improved curbside management, which optimizes mobility, safety and access for a wide variety of activities occurring along the "curb".

Microtransit and micromobility support equity in urban environments by providing affordable and flexible transportation options to underserved communities, particularly in areas where traditional public transit may be limited or inefficient, and to individuals who might otherwise face transportation barriers, such as low-income populations, the elderly, and people with disabilities. By filling gaps in the transportation network, microtransit and micromobility ensure more inclusive mobility solutions, helping to bridge the transportation divide in urban areas.

Implementation

The Fairfax County Comprehensive Plan ("Plan") traditionally focused primarily on expanding traditional transit options. Over time, the need for more flexible, demand-responsive solutions has been identified, especially in areas where traditional services are less cost-effective or feasible, and as a complementary service to fixed-route public transportation like buses and Metrorail. The County's approach to microtransit has largely been through pilot projects and public-private partnerships (PPPs). These programs aimed to reduce the reliance on personal vehicles and provide alternatives to underserved areas that lack adequate access to essential services or resources. In the context of transportation, underserved areas typically face limited or insufficient public transit options, making it difficult for community members to access jobs, healthcare, education, and other necessary services. Lessons from these pilots have informed ongoing discussions on making microtransit a more permanent fixture in the transportation ecosystem.

The Plan has only recently begun to incorporate micromobility considerations. Earlier versions of the Plan focused heavily on pedestrian and bicycle infrastructure, but the rise of shared micromobility services, particularly e-scooters and e-bikes, has prompted the County to reassess its infrastructure, policy, and regulatory frameworks to accommodate these new mobility options. This has included the expansion of bike lanes and shared use paths (SUP), especially in more urban areas such as Tysons. In 2021, Fairfax County adopted regulations specifically for the operation of e-scooters, which include speed limits, parking requirements, and safety measures. The introduction of shared mobility services such as Capital Bikeshare has been an important step; however, broader adoption across the County is needed. This may include implementation of dedicated infrastructure and consideration of how micromobility can complement public transit and reduce car dependency, as well as complementary Plan policies.

The County has acknowledged the long-term potential of AVs in various planning documents but has not yet established a formal strategy or policy for their integration into the transportation network. While no large-scale deployment has occurred, Fairfax County has been actively engaged in regional and national discussions and studies on autonomous vehicle technology to better understand how AVs can be integrated into existing transportation networks and infrastructure. Some exploration work, particularly in partnership with the Washington Metropolitan Area Transit Authority (WMATA), has examined how autonomous shuttles or other AV services might serve as a solution for first/last mile connections or serve areas with low transit ridership.

Currently, there are no specific local regulations in Fairfax County governing the deployment or operation of AVs. Most AV testing and pilot programs in Virginia operate under state-level oversight. As AV technology progresses, Fairfax County may benefit from exploring a regulatory framework to address critical issues such as safety standards, data privacy, infrastructure preparedness, and the integration of AVs into diverse traffic conditions, aligning with broader state and regional policies. Fairfax County has a significant opportunity to embrace new mobility technologies.

While progress has been made through existing Plan policies, pilot programs and preliminary regulatory efforts, a more cohesive and strategic approach is needed to fully leverage the benefits of microtransit, micromobility, and autonomous vehicles. Developing a clear, future-focused policy and related implementation guidance will position Fairfax County as a leader in innovative, sustainable, and inclusive transportation solutions.

Analysis

Microtransit and micromobility can be more cost-efficient than traditional transit systems, particularly for short-distance or low-demand routes. Microtransit operates on on-demand routes, allowing for flexible scheduling. Vehicles are only deployed when and where they are needed, reducing the overall cost of operating and maintaining the service. Microtransit services also require less infrastructure investment when compared to traditional fixed-route services, which rely on extensive networks of buses and trains, such as the Metro. Smaller vehicles complement existing public transportation infrastructure, allowing for better use of resources and decreasing the need for additional services. Flexible, on-demand service supports areas with irregular demand or sparse transit coverage. Micromobility, such as bicycles, e-bikes, and e-scooters, offer low-cost alternatives for short-distance trips, helping to alleviate congestion and reduce the demand for public transit.

AV operation is designed to anticipate human error and unpredictability, aiming to reduce, and ultimately eliminate, serious injuries and fatalities. By optimizing routes and reducing human errors like sudden braking or inefficient lane changes, AV can improve traffic flow and reduce travel times. As a part of a microtransit service, AV may offer a cost-effective alternative to traditional transit systems, especially for areas with irregular demand or low ridership. Unlike fixed-route services that require continuous operation regardless of ridership levels, AV are deployed when necessary and stored off site, minimizing fuel and maintenance expenses and freeing up parking and curb space in urban areas. While AV technology has been piloted and tested in various locations, the full realization of its benefits such as enhancing connectivity remains a work in progress in many of these areas. In some places where AVs are already in use, such as Waymo's deployment in parts of Phoenix, Arizona, and autonomous shuttle services in cities like Las Vegas, Nevada, and Columbus, Ohio, among others, there have been promising indications of increased access to transportation, particularly in underserved or suburban areas. For AV technology to fully deliver these benefits, it will require further infrastructure investments, regulatory frameworks, and technological advancements. Therefore, while the benefits of AVs in terms of connectivity and inclusivity are visible in specific pilots, these outcomes are still unfolding and not yet universally realized across all regions where AVs are being tested or deployed.

Trends

Key emerging federal and regional trends offer significant potential to enhance mobility, reduce congestion, and support equitable and sustainability goals. While Fairfax County has made progress in piloting microtransit and micromobility services, as well as participating in AV studies, there is a clear need for more policies in the Plan to provide broader guidance for these trends. This may include integrating these emerging technologies into the transportation network and designing infrastructure to accommodate trends to ensure complimentary services that do not exasperate equity gaps, as well as leveraging public-private partnerships (PPPs) and pilot programs.

Federal actions, including key legislation, reflect a shift toward more eco-friendly and technology-driven mobility solutions, emphasizing these technologies. The DMV (District of Columbia,

Maryland, and Virginia) region and East Coast corridor, with their dense populations and growing urban centers, are particularly well-positioned to adopt these innovations. Local jurisdictions are leading efforts through pilot programs, policy development, and infrastructure investments that promote microtransit, micromobility, and AVs, underscoring the region's commitment to advancing flexible and innovative transportation systems. Case studies are included in Appendix I with national, regional, and local examples.

National

National trends, including federal legislation and actions, have amplified the potential adoption of microtransit, micromobility, and AV. These efforts reflect a growing focus on sustainable, equitable, and technology-driven transportation solutions across the United States

- The Bipartisan Infrastructure Law (BIL) (Infrastructure Investment and Jobs Act (IIJA)) provided substantial funding for transportation infrastructure improvements, including investments in public transit, electric vehicles, and emerging mobility technologies. The law allocated funding to public transportation, supporting the expansion of microtransit services and infrastructure for micromobility options such as bike lanes and e-scooter programs. In addition, it emphasized technology deployment for AV by funding research and testing in connected vehicle technologies, smart infrastructure, and safety standards for AVs.
- The Inflation Reduction Act (IRA) focused primarily on addressing climate change and reducing carbon emissions, with significant funding for clean energy and sustainable transportation initiatives. Although not directly focused on microtransit or micromobility, the IRA included incentives for electric vehicles (EVs) and investments in EV charging infrastructure, which indirectly support the adoption of micromobility options like electric bikes and scooters. The emphasis on emissions reduction aligns with the goals of reducing car dependency and promoting more sustainable urban mobility through microtransit and AVs.
- The National Highway Traffic Safety Administration (NHTSA) has issued a series of guidelines to promote the safe testing and deployment of AV. Issued in 2017, the Automated Driving Systems 2.0 guidelines and the subsequent updates provide a framework for AV testing and operations, encouraging states and cities to embrace AV technology. This has led to expanded AV testing programs in states such as California and Florida, and cities such as Las Vegas and Phoenix, where autonomous shuttles are increasingly being used in microtransit applications. The ride-hailing service company, Waymo, operates AVs in San Francisco, Los Angeles, and Phoenix.

Several cities across the United States, including New York, Los Angeles, and Portland, have adopted Vision Zero policies aimed at eliminating traffic fatalities and injuries. These policies encourage the development of safe, accessible transportation options, including microtransit and micromobility services, to reduce the need for car trips and make streets safer for pedestrians and cyclists. The push for safer streets and more inclusive transportation aligns with national efforts to reduce emissions and promote multimodal transportation systems.

States such as California and Florida have taken a proactive approach to AVs and micromobility. California has passed legislation supporting AV testing and deployment, with cities like San Francisco and Los Angeles leading in piloting autonomous shuttles. Florida has also emerged as a leader in AV policy, allowing AVs to operate without human drivers under certain conditions. Meanwhile, states like Oregon have embraced micromobility by passing regulations that support e-

scooter and bike-sharing programs. These state-level actions are further amplified by federal and local trends, pushing cities to explore more sustainable and tech-driven mobility solutions.

Regional

Led by a growing population in dense urban cores, the DMV region and the East Coast corridor have seen growing interest in microtransit, micromobility, and AV.

The Metropolitan Washington Council of Governments (MWCOG) plays a critical role in shaping transportation policy for the DMV region. As part of its long-range planning efforts, MWCOG has placed a strong emphasis on multimodal transportation systems, which include the integration of microtransit, micromobility, and AVs. The long-range transportation plan, *Visualize 2045*, sets goals for reducing greenhouse gas emissions, improving accessibility, and promoting sustainable transportation modes, including expanded use of microtransit and micromobility options like bike-sharing and e-scooters. This plan recognizes the importance of integrating emerging technologies to reduce traffic congestion and support regional economic growth. The Congestion Management Process (CMP) identifies opportunities for mitigating congestion through demand-responsive transportation modes, such as microtransit, which can serve as a complement to the region's extensive transit network. This planning framework encourages regional jurisdictions to adopt flexible and tech-driven solutions to reduce car dependency.

Several jurisdictions in the DMV region have launched microtransit pilot programs to provide flexible, demand-responsive transit services in areas with lower ridership or limited access to fixed-route transit options. In the past, Washington, DC has also explored microtransit options through its Circulator bus service and other demand-responsive transit initiatives. These services are designed to reduce traffic congestion and improve mobility for underserved communities, while also exploring innovative models for difficult to serve areas with traditional buses.

The Maryland Department of Transportation (MDOT) established the Maryland Autonomous Vehicle Working Group to facilitate AV testing and regulatory development. The group collaborates with state agencies, local governments, and private-sector partners to promote AV technology while ensuring safety and compliance with state regulations. Maryland has hosted AV pilot programs, such as autonomous shuttles in Montgomery County and along the I-270 corridor, which are designed to explore how AV technology can improve transportation efficiency and safety in densely populated areas. Maryland's efforts are closely aligned with MWCOG's regional transportation planning, ensuring that AV policies and testing complement broader regional goals, such as reducing emissions, improving safety, and enhancing mobility.

The District's Department of Transportation (DDOT) has created a robust regulatory framework that includes safety guidelines, designated parking zones, and integration with public transit. Data from micromobility programs has shown strong demand, leading to ongoing expansions in both the number of vehicles and the network of bike lanes and protected paths. Washington, DC has also conducted AV pilot programs, which have provided valuable insights into how autonomous technology can navigate dense, complex traffic environments.

The East Coast corridor, including cities like New York, Philadelphia, and Baltimore, has seen a growing emphasis on shared mobility and AV initiatives that are relevant to the DMV region. The I-95 Corridor Coalition, a multi-state transportation planning organization, has been studying how connected and autonomous vehicles (CAVs) can improve safety and efficiency along this heavily traveled highway. Data collected from AV testing along the corridor informs regional and state transportation planning efforts, including in Maryland and Virginia. Cities like Philadelphia and New

York have invested heavily in micromobility solutions, such as bike-sharing and e-scooters. These trends are influencing transportation planning across the East Coast, as shared mobility becomes a core component of efforts to reduce traffic congestion and carbon emissions.

Local

Local jurisdictions in the Washington Metropolitan Area have been at the forefront of implementing policies that promote microtransit, micromobility, and AV. Fairfax County has explored microtransit through programs such as *Fastran*; operating in Fairfax County, Falls Church, and the City of Fairfax, this service supports community members by providing transportation to critical care centers, adult day health care, therapeutic recreation services, as well as senior centers and residences. Furthermore, the Fairfax Connector's program *Relay* (2020-2023), aimed at improving first/last mile connectivity in the Mosaic district by providing an autonomous shuttle service to/from the Dunn Loring-Merrifield Metro Station. These programs highlight the importance of integrating alternative forms of transportation to expand service coverage and improve connectivity, particularly in suburban and lower-density areas.

Further, Fairfax County and other localities have integrated Capital Bikeshare into their urban framework, providing community members with easy access to bikes for short trips, particularly as the Silver Line extension has created new opportunities for connectivity within communities. As part of the region's commitment to reducing emissions and congestion, investment in bike infrastructure and planning efforts to make biking and scooting more viable options for community members has increased.

Local jurisdictions in the DMV are playing an important role in amplifying microtransit, micromobility, and AV through pilot programs, infrastructure investments, and policy development. Services aim to reduce transportation inequities and improve access to employment centers, schools, and healthcare. Services in the region have been explored through pilot programs to provide on-demand, flexible transportation in areas where traditional transit is less effective. These efforts, often coordinated through regional entities like MWCOG, are helping to create a more flexible, efficient, and sustainable transportation network across the Washington Metropolitan Area. By addressing local challenges and integrating new technologies into their transportation planning, these jurisdictions are setting a precedent for how cities and counties across the country can adopt emerging mobility solutions.

Feasibility & Consideration

The safe operation and integration of microtransit, micromobility, and autonomous vehicles (AV) into the existing transportation network hinges on several key factors. This includes a thorough assessment of the existing infrastructure, public education, and regulatory support. Investment in smart infrastructure, such as designated lanes for micromobility devices, charging stations for electric vehicles, and real-time tracking systems for microtransit, will be crucial to support these services and ensure seamless connectivity. In parallel, public education efforts and community engagement, such as pilot programs and feedback mechanisms, will help address concerns and build trust in these technologies, particularly regarding safety and reliability.

Furthermore, developing a regulatory framework that supports the safe operation and integration of these transportation options is critical. This includes establishing clear guidelines for micromobility usage, setting safety standards for autonomous vehicles, and ensuring compliance with existing public transit regulations. Collaboration with local agencies, technology providers, and community

stakeholders will be necessary to create a cohesive strategy that maximizes the benefits of these innovations. Equity must be at the forefront of implementation strategies to ensure that all community members, particularly those in underserved areas, have access to the enhanced mobility options provided by microtransit, micromobility, and autonomous vehicles. This may involve targeted outreach efforts, subsidized fares, or dedicated services to ensure inclusivity and broaden the positive impacts of these emerging transportation solutions across Fairfax County.

The efforts above rely on programmatic, regulatory, and infrastructure initiatives outside the scope of the Plan. However, they could be supported or enhanced by Plan policies encouraging the use of these emerging technologies to be implemented through the entitlement process. By considering these factors, Fairfax County can create an adaptive emerging transportation ecosystem.

Policy Recommendations

The integration of microtransit, micromobility, and autonomous vehicles (AV) into the transportation framework of Fairfax County presents a transformative opportunity to enhance urban mobility and connectivity. These alternative transportation options can address gaps in existing transit systems and offer flexible, cost-effective on-demand services that adapt to the unique needs of the community. AVs can optimize traffic flow, minimize human error, and free urban space through efficient deployment. By improving accessibility, reducing reliance on single-occupancy vehicles, and promoting sustainable travel solutions, these innovations can significantly alleviate traffic congestion and environmental impacts. Moreover, an emphasis on equity can ensure that underserved populations benefit from enhanced mobility options, fostering a more inclusive community. As Fairfax County explores these emerging technologies, a comprehensive approach that includes Plan policies, infrastructure investment, public education, and regulatory support will be essential to maximize their potential and create a robust, future-ready transportation ecosystem that meets the diverse needs of its community members.

Plan policy recommendations for microtransit, micromobility, and autonomous vehicles (AV) should create comprehensive frameworks that encourage innovation, ensure safety and equity, integrate these technologies with existing transit systems and transportation networks, and prioritize sustainable infrastructure development to support widespread adoption. Although there are complexities and uncertainties surrounding autonomous vehicles, policy must focus on prioritizing technological progress with public safety, privacy, and infrastructure needs. A primary Plan policy focus should ensure that developments account for the space needed to support micromobility, microtransit, and autonomous vehicles within the planning and development process. This paired with the specific recommendations below will ensure the County is able to accommodate a variety of mobility options to serve community members, help to reduce emissions from the transportation sector, and advance its transportation vision. This paper provides information, insights and potential considerations to inform the future development of policies, programs or other regulations and any proposed recommendations in this paper should be viewed as possible discussion points rather than finalized courses of action.

- Micromobility: Enhance the infrastructure for micromobility, including the expansion of bike lanes, protected paths, and designated e-scooter parking zones. Increase the availability of bike-sharing and e-scooter services, ensuring equitable access across different parts of the County. Develop policies that regulate the safe use of micromobility options and encourage integration with public transit for short-distance trips.

- Microtransit: Currently, Fairfax County does not have an explicit Plan policy for microtransit; however, microtransit has been implemented through existing transportation regulations, policies, and programs. Expand pilot programs for on-demand microtransit services to address first/ last mile connectivity and improve access to underserved areas. Integrate these services with existing public transit, such as Metrorail and Fairfax Connector, to create a seamless, multimodal transportation system. Additionally, ensure equitable service coverage for all communities.
- Autonomous Vehicles: Collaborate with regional jurisdictions and private-sector partners to pilot AVs in specific corridors, focusing on transit station areas, commercial centers, and underserved areas. Prioritize AV solutions that address transportation equity and contribute to the County's sustainability goals, including reducing emissions and traffic congestion.

By adopting policies, programs, and other regulations that address the integration, infrastructure, and framework of new and emerging mobility methods, Fairfax County can lead the region in embracing emerging transportation technologies while ensuring safety, accessibility, and sustainability.

Appendix I: Case Study

Several successful case studies highlight the effectiveness of microtransit, micromobility, and autonomous vehicles (AV). The technology company that provides on-demand shared ride services, Via, is aiming to improve urban mobility by offering cost-effective, flexible transportation options. Via partners with cities and transit agencies to integrate its service into existing public transportation networks, providing a convenient and efficient solution for first mile/ last mile connectivity. In New York City, Via has partnered with public transit agencies to provide on-demand, shared rides that complement existing transit systems, reducing congestion and offering cost-effective mobility for underserved neighborhoods. In Camden, New Jersey, where public transit options were previously limited, Via has enabled community members access to affordable, on-demand transportation solution that connects community members to key destinations such as employment centers, healthcare facilities, and public transit station areas, improving mobility in underserved areas, thus reducing transportation-related barriers. In Jersey City, New Jersey, Via's integration with the existing transit network has enhanced the efficiency of the city's overall transportation system. The microtransit service has made it easier for community members to connect to major transit station areas like PATH stations, ferry terminals, and bus routes, and improving overall connectivity and reducing the reliance on personal vehicles. This improved connectivity has not only reduced traffic congestion but has also contributed to a more inclusive and sustainable urban mobility solution.

By offering shared rides, Via has been able to reduce the number of single-occupancy vehicles on the road, which in turn helps decrease traffic congestion. In New York City and Jersey City, where traffic congestion is a significant issue, Via's services have led to a reduction in the need for personal car usage, especially for short trips that would otherwise contribute to traffic bottlenecks. Quantifying the reduction in congestion could be done by measuring the decrease in vehicle miles traveled (VMT) or the reduction in average traffic speeds during peak hours. Via's integration with existing transit networks, as seen in Jersey City, has enhanced overall connectivity and reduced the need for personal vehicles. In Camden, Via's microtransit service has provided affordable, on-demand rides to underserved communities, increasing access to essential services like healthcare, jobs, and public transit connections. This improved access can be quantified by tracking the number of riders, the frequency of trips to key destinations, and the reduction in travel time for community members who previously had limited transportation options. For instance, metrics such as increased ridership to hospitals, employment centers, or other vital areas could be used to assess this benefit. The benefits of Via's microtransit service can be quantified through data such as ridership numbers, reduced vehicle miles traveled, cost savings for community members, improved connectivity to essential services, and reductions in traffic congestion and emissions.

On the micromobility front, Lime, Bird, Spin, and Superpedestrian have transformed urban travel in cities like Washington, DC and Los Angeles, CA, with e-scooters and bikes providing sustainable, last-mile solutions that reduce reliance on cars and increase access to public transit. These companies provide shared micromobility services, primarily offering electric scooters and bikes for short-term rentals in urban areas. Lime is one of the largest providers of electric scooters and bikes globally, focusing on reducing traffic congestion and promoting eco-friendly transportation. Bird is another leading electric scooter company, operating in numerous cities worldwide and offering convenient, dockless transportation options for short trips. Spin, owned by Ford, provides electric scooters and bikes, aiming to enhance first mile/ last mile connectivity and reduce carbon emissions in cities. Superpedestrian is a micromobility company known for its advanced scooter

technology, focusing on durability and safety, and has launched its own fleet of electric scooters in several cities. These case studies in New York, New Jersey, and California demonstrate how microtransit and micromobility can adapt to diverse environments, improving mobility and accessibility. Launched in 2010, the Capital Bikeshare service operates across Washington, DC and Fairfax County, providing community members and visitors with a flexible and convenient transportation alternative. Bikes are available at docking stations located throughout the region, allowing users to rent bikes for a set duration and return them once they are done. Capital Bikeshare has become an integral part of the transportation ecosystem and is a prime example of how bike sharing can support sustainable urban mobility and reduce single occupant vehicle use.

Figure 1 Capital Bikeshare in Fairfax County

Finally, AV technology is being established by Tesla and Waymo. Waymo's autonomous vehicles are designed to reduce human error by using combination of sensors, cameras, radar, lidar, GPS, and artificial intelligence (AI) to navigate and drive safely. This improves vehicle efficiency and minimizes human-caused traffic disruptions. AV are classified into different levels by the Society of Automotive Engineers (SAE), ranging from Level 0 (no automation) to Level 5 (full automation), where the vehicle can operate in all conditions without human input. Current models, such as Tesla's Autopilot (Level 2) and Full Self-Driving (Level 3), operate with the intention of human supervision, although they can handle certain driving tasks independently. While Tesla has gained significant attention for its advanced driver-assistance systems, Waymo's approach to fully autonomous vehicles, particularly in urban environments like San Francisco, Los Angeles, and Phoenix, offer a contrasting vision of the future of self-driving technology. Waymo's fleet operates without a safety driver in some instances, demonstrating advancements to Level 4 autonomy. These cities provide an ideal testing location for refining their systems to handle diverse road scenarios like heavy traffic, unpredictable pedestrians, and variable weather conditions. AV use enhances connectivity and fosters inclusivity by providing transportation solutions that are more accessible, affordable, and efficient for a diverse range of people. AVs increase access to transportation in underserved areas where traditional transit options are limited or non-existent. By eliminating the need for a driver, AVs reduce barriers for people with disabilities, the elderly, and those without driving licenses, ensuring they can travel independently. These vehicles can be designed with adaptive features to accommodate different needs, such as wheelchair accessibility or assistive technologies for people with visual impairments. By embracing new technologies, enhanced connectivity can benefit the community and foster a more inclusive and sustainable approach to urban mobility.

Figure 2 Waymo Jaguar I-PACE in San Francisco