2019

Final Report

DRPT STATEWIDE INTEGRATED MOBILITY INITIATIVE

5/16/2019

PREPARED BY:

KIMLEY-HORN and IBI GROUP

PREPARED FOR:

VIRGINIA DEPARTMENT OF RAIL AND PUBLIC TRANSPORTATION

Contents

Executive Summary ..... **iii**

1. Introduction **1**

1.1 Purpose and Objectives 1

1.2 Background 2

1.3 Stakeholder Engagement 4

2. Domestic and International State of the Practice **6**

2.1 State of the Practice Summary 6

2.2 Shared Mobility Concepts 8

2.3 Shared Mobility Case Studies 26

2.4 Transit Technology State of the Practice 47

2.5 Conclusions 52

3. Virginia State of Play **54**

3.1 State of Play Summary 54

3.2 Active Work in Shared Mobility 55

3.3 Survey Results and Other Feedback 57

3.4 Virginia Technology Plans 62

3.5 Data and Business Intelligence 64

4. Recommendations **65**

4.1 Recommendations Summary 65

4.2 Investment Needs 67

4.3 Partners 67

References **84**

Appendix

Appendix A: Additional Shared Mobility Examples

Appendix B: Stakeholder Survey Summary

Appendix C: Transit Technology Acronym Guide

Figures

Figure 1. Project Scope 1

Figure 2. Transit Ridership Trends: Nationwide vs. Virginia 2

Figure 3. Shared Mobility Solutions (GAO, 2018) 6

Figure 4. Shared Mobility Modal Split (CB Insights, 2018) 7

Figure 5. Mobility on Demand Sandbox Grantees (GAO, 2018) 11

Figure 6. Shared Mobility Trips in the Context of FTA Definition of Modes (IBI Group, 2018) 14

Figure 7. Shared Mobility Service Models (Susan, Cohen, & Zohdy, 2017) 14

Figure 8. Insurance Handover Scenarios (Susan, Cohen, & Zohdy, 2017) 25

Figure 9. Shared Mobility Activity in Virginia 55

Figure 10. Effectiveness of Traditional Transit Service 58

Figure 11. View on Shared Mobility 59

Figure 12. Interest in Partnering with the Private Sector 59

Figure 13. Desired Support from DRPT 60

Figure 14. View on Transit Service Change 61

Figure 15. View on Technology Needs 61

Figure 16. Transit Technology Deployment Matrix 63

Figure 17. Recommendations Summary 66

Tables

Table 1. Shared Mobility Case Studies 28
Table 2. Deployment Status of Transit Technologies 48

EXECUTIVE SUMMARY

The Virginia Department of Rail and Public Transportation (DRPT) has embarked on a Statewide Integrated Mobility Initiative to assist the department and its partner agencies in navigating the rapidly changing shared mobility landscape. New and alternative transportation services—often involving shared use of a vehicle or other mode and enabled by technology—continue to evolve and enter the market, providing people with greater convenience in requesting, tracking, and paying for trips. Examples of these services include on-demand ride services (transportation network companies [TNCs] such as Uber and Lyft), microtransit, technology-enabled shuttle services, carsharing, bikesharing, and scooters. These services can both compete with and complement transit service. At the same time, public transit ridership has experienced a recent decline nationwide and in the Commonwealth—concurrent with DRPT transitioning to a performance-based funding methodology. This Statewide Integrated Mobility Initiative thus intends to do the following:

- Identify what is happening in Virginia, the U.S., and around the world in terms of (1) integrating shared mobility and transit and (2) utilizing transit technology to measure and improve operations and tailor service in evolving mobility landscapes
- Identify the positive and negative impacts of shared mobility on the transit industry in Virginia
- Document current and planned technology deployments of Virginia transit agencies, including planned partnerships or pilots involving shared mobility providers

This initiative ultimately develops recommendations for DRPT and its partner agencies to implement in light of the changing mobility industry—for example, roles, investment needs, and projects. These recommendations are rooted in stakeholder input from DRPT's staff, transit agencies, and research on the state of play in Virginia and state of the practice nationally and internationally.

Domestic and International State of the Practice

This document contains an extensive review of domestic and international trends and recent case studies relating to shared and integrated mobility. It provides a summary of the current shared mobility solutions being offered, such as shared vehicles (e.g., carshare, bikeshare, and scooter share), shared ride services (e.g., carpool and vanpool), ridehailing/ridesourcing (TNCs), and microtransit services. It discusses various service models (membership structures, payment options, etc.) and types of shared mobility partnerships with public transit agencies. Several challenges and opportunities related to shared mobility are laid out as well as the potential roles of transit agencies and regulating bodies. Finally, a selected suite of recent case studies is provided representing the general state of practice in the domestic and international mobility landscape. The findings from this state-of-the-practice scan helped feed the recommendations for DRPT and its partner agencies.

Virginia State of Play

Coupled with the external state-of-the-practice scan, extensive stakeholder outreach was conducted to transit agencies and other related transportation demand management agencies within the Commonwealth. This outreach aimed to understand the current state of play of

integrated shared mobility and transit technology in Virginia. Stakeholder outreach included (1) an online survey on stakeholders' understanding of shared mobility services and use of technology and data; (2) a series of webinars discussing the project goals and objective and allowing stakeholders to voice specific concerns and research interests; (3) a statewide Transit Technology Roundtable discussion; (4) ITS Deployment Plans being updated and completed by each agency detailing existing and planned technology deployments; (5) in-person workshops to discuss findings from the state of the practice and preliminary recommendations; and (6) a webinar to present the final recommendations and implementation plan to stakeholders.

Several major findings were gleaned from this stakeholder outreach, including the following:

- Agencies understand that shared mobility and TNC services are not going away, and these services are viewed as more of an opportunity than a threat to public transit service in Virginia
- While traditional demand response/paratransit service has been the extent of shared mobility services in many Virginia communities, several transit agencies are beginning to explore alternative transit services or partnerships
- There is a mix of agency interest, readiness, and executive support for partnering with shared mobility providers, and there is a desire for DRPT to provide guidance and support
- There is a collective view that transit operations and business will change in the future. Transit will become more technology dependent. This means that agencies will need to continue to invest in transit technology.

Recommendations for DRPT and Partner Agencies

This document presents a series of recommendations for DRPT and its partner agencies on their roles for advancing integrated mobility in the Commonwealth. These recommendations have been compiled based on the state-of-the-practice scan and the assessment of the state of play across DRPT's partner agencies. These recommendations fall into three general categories: (1) DRPT program development; (2) statewide contracts and platforms; and (3) local projects. The recommendations were presented to stakeholders at workshops in fall 2018 and were prioritized based on their input. **Figure ES-1** on the following page summarizes the recommendations and anticipated timeline for implementation. This document provides summary sheets for each recommendation, including expected outcomes and partners, investment needs, and similar examples from elsewhere.

The recommendations provided in this document will require investment including both DRPT staff time and funding to cover external costs such as vendor or consultant support. For the most near-term initiatives—those shown in **Figure ES-1** as taking place in the next 1–2 years (Fiscal Year [FY] 2020 and FY2021)—it is estimated that the following resources will be needed:

Recommendation	DRPT Staff Hours	External Costs
A.2. Scoping and Requirements Guidance	40	$60,000–$120,000
A.3. Grant Program Restructuring	40–80	N/A
B.1. Statewide Technology Contracts	80–160	$40,000–$80,000
B.3. TNC Partnership(s)	80–120	$300,000–$600,000
Total	**200–320**	**$400,000–$800,000**

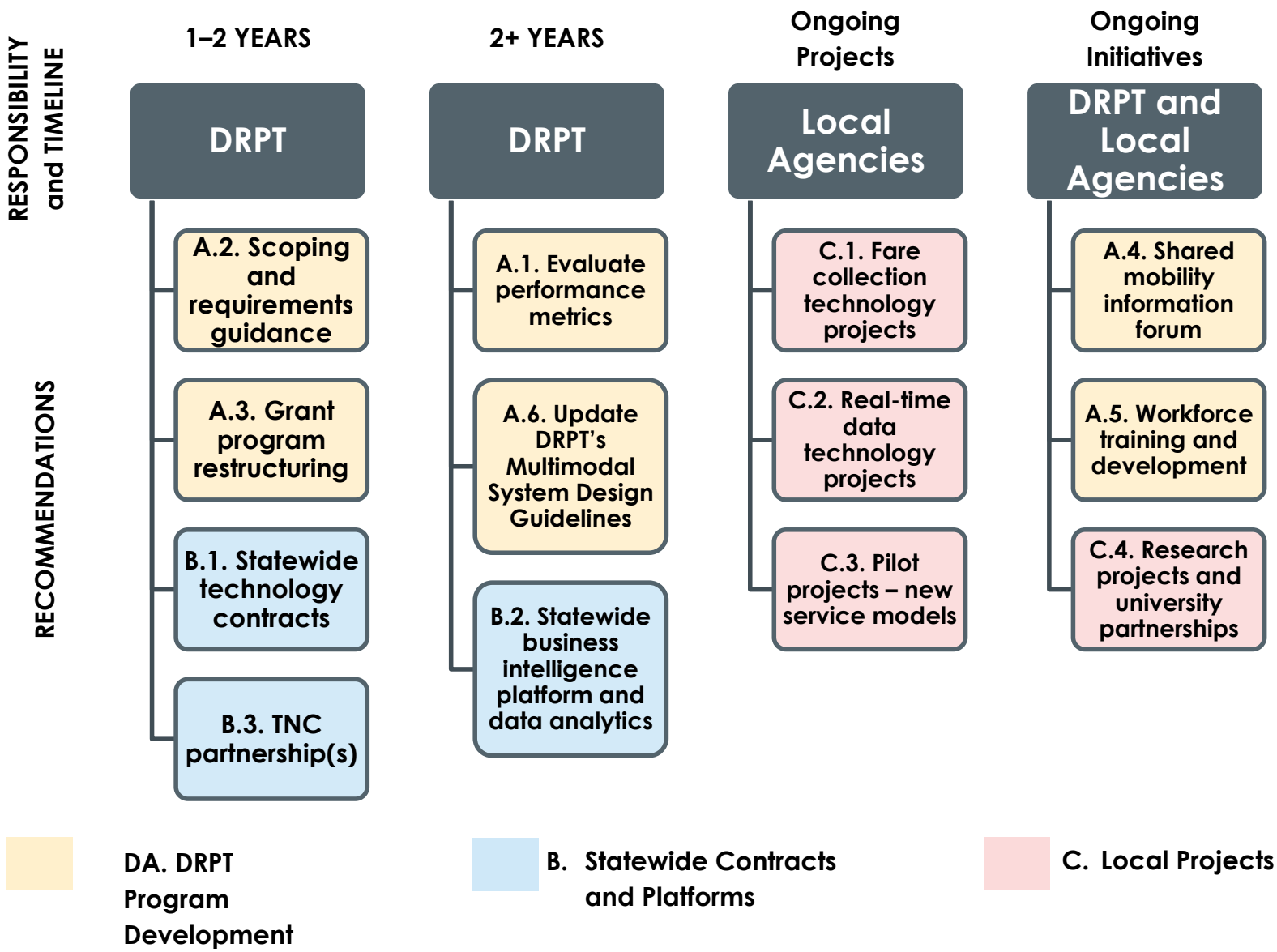


Figure ES-1: Recommendations Summary

1. INTRODUCTION

1.1 Purpose and Objectives

Transportation across the U.S. and around the world is being rapidly transformed by technology. The transit industry, particularly in urban areas, is witnessing the impacts of technological innovation. New and alternative transportation services—often involving shared use of a vehicle enabled by technology—continue to evolve and emerge, providing people with greater convenience in requesting, tracking, and paying for trips. Examples of these services include on-demand ride services (transportation network companies [TNCs] such as Uber and Lyft), microtransit or technology-enabled shuttle services, carsharing, bikesharing, and even other small shared vehicles such as scooters and mopeds. These services both compete with and complement transit as part of the new mobility landscape. More data than ever is being collected on how people travel using these services—much of which is held privately by the service provider and not publicly available.

These changes cannot be ignored. DRPT understands this and has embarked on a Statewide Integrated Mobility Initiative. This initiative will assist DRPT and its partner agencies in navigating these changes in part by taking advantage of emerging transit technology and partnership opportunities.

The Statewide Integrated Mobility Initiative intends to do the following:

- Identify what is happening in Virginia, the U.S., and around the world in terms of (1) integrating shared mobility and transit and (2) utilizing transit technology to assess operations and tailor service in evolving mobility landscapes.
- Identify the positive and negative impacts of shared mobility on the transit industry in Virginia.
- Document current and planned technology deployments of Virginia transit agencies, including planned partnerships or pilots involving shared mobility providers.

This Initiative ultimately develops recommendations for DRPT and its partner agencies for what needs to be done in light of the changing mobility industry—for example, roles, investment needs, and projects. These recommendations are rooted in stakeholder input from DRPT's staff, its partner agencies, and research on the state of play in Virginia and state of the practice nationally and internationally. This process is noted in **Figure 1**.

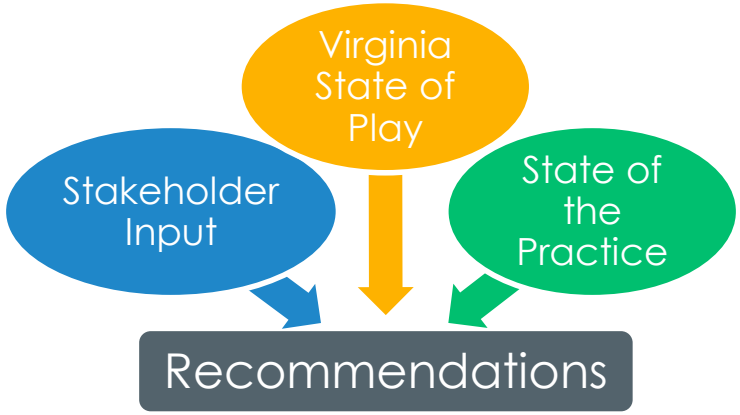


Figure 1. Project Scope

1.2 Background

1.2.1 Transit Ridership Trends in Virginia and Nationwide

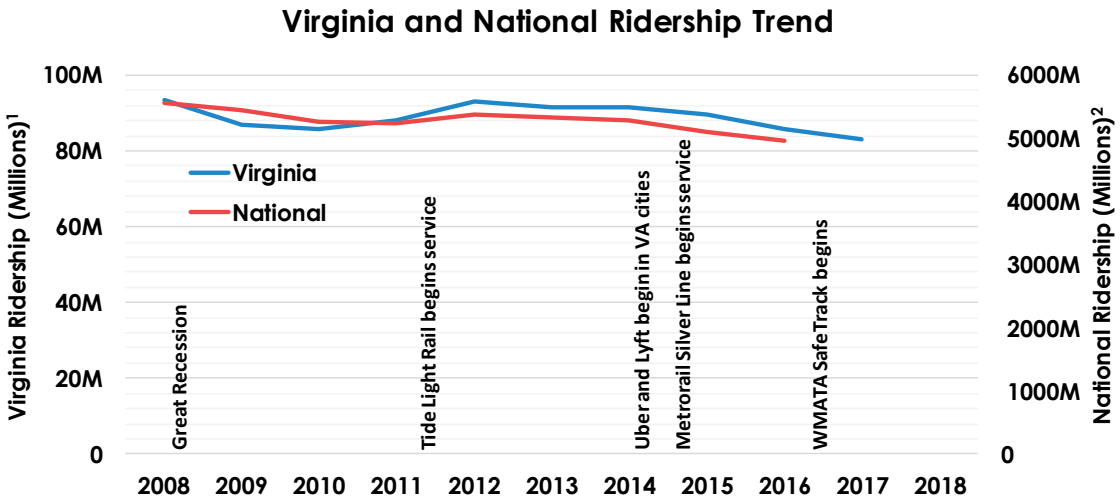
There has been much discussion at both the state and national level in regard to recent declines in public transportation ridership. A 2018 American Public Transportation Association (APTA) report noted that while many transit agencies rebounded from the Great Recession (2008–2009) to see ridership increases through 2014, ridership has stayed flat or declined over the past few years (Grisby, Dickens, & MacPherson-Hughes, 2018). Generally, this national trend has also been observed in Virginia. **Figure 2** shows these trends since 2008 at both the statewide and national level. Note that this figure displays ridership for fixed-route bus service at the national level and ridership for the 21 largest DRPT transit agencies, who are also participating in this initiative, not including Washington Metropolitan Area Transportation Authority (WMATA) heavy rail service to avoid skewing the trend.

These recent ridership declines have been attributed to several factors, which APTA groups into four broad categories:

1) **Erosion of time competitiveness** – Transit, particularly buses, struggles to compete with other modes of travel when roadways are congested. As the economy has improved following the Great Recession, car ownership and vehicle miles traveled have expanded— especially since gas prices decreased in late 2014—increasing congestion.

2) **Reduced customer affinity and loyalty** – Potential transit riders have more travel options available than ever, ranging from TNCs to other shared mobility services such as carshare/bikeshare/scooter share in addition to increased ability to telework. At the same time, many transit agencies have suffered service reductions (especially during off-peak times) or reductions in schedule reliability due to maintenance issues. These factors have reduced loyalty of riders to transit, including less frequent use of monthly passes.

3) **Erosion of cost competitiveness** – In conjunction with the first two broad factors, the cost savings of using transit have been reduced for potential riders in many cases. Examples



Notes:
[1]Virginia ridership for 21 stakeholder grantees of Statewide Integrated Mobility Initiative (fixed-route, light rail, and commuter rail modes)
[3]National bus ridership from National Transit Database

Figure 2. Transit Ridership Trends: Nationwide vs. Virginia

include reduced-cost "ride-splitting" or carpool options offered by TNCs, reduced gas prices and parking prices for auto travel, and some cases of fare increases for transit.

4) **External factors** – For example, some major developments and amenities moved to areas not currently (or easily) served by transit, or there were changes in parking availability and pricing.

Put simply, potential transit riders are more likely than ever to take the mode that they feel best suits each individual trip.

1.2.2 Virginia's Performance-Based Funding

The 2018 Virginia General Assembly enacted numerous reforms to the public transportation grant programs administered by DRPT under Chapters 854 and 856 of the 2018 Virginia Acts of Assembly. In order to successfully ensure timely implementation of these reforms, DRPT created the Making Efficient and Responsible Investments in Transit program (MERIT). Effective July 1, 2018, all revenues deposited into the Mass Transit Trust Fund (MTTF) must be allocated annually by the Commonwealth Transportation Board as follows:

- 31 percent for statewide operating assistance grants
- 12.5 percent for statewide capital assistance grants
- 53.5 percent for distribution to Northern Virginia Transportation Commission (NVTC) for WMATA capital purposes and operating assistance
- Up to 3 percent of remaining funds awarded as special project grants subject to Commonwealth Transportation Board (CTB) approval

Beginning in Fiscal Year (FY) 2020, all statewide transit operating funding will be distributed based on performance factors. All statewide capital assistance grants will be subject to a project-based prioritization process competitive with other applications statewide and along project categories for state of good repair, minor enhancement, and a separate SMART SCALE-like process for major expansion projects. Details on MERIT and the CTB approved policies for the implementation of statewide operating funding and capital prioritization are publicly available through DRPT[1].

1.2.3 What is Integrated Mobility?

Virginia's economy and the national economy continue to grow along with population, particularly in urban areas. Concurrently, the number of personal trips—whether to work, shop, or play—continues to grow, while the number of trips on fixed-route transit has stagnated or declined in many areas.

This initiative seeks to explore the evolving paradigm of integrated mobility, the relationship between transit and other shared mobility modes of travel, and how technology can enhance this relationship. This initiative explores the potential for partnerships between transit agencies and shared mobility providers, which could include first/last mile connection services, mobile app or fare payment integration, shared

[1] http://www.drpt.virginia.gov/transit/merit-statewide-public-transportation-capital-grants-and-operating-assistance/

branding, data-sharing agreements, third-party contracting or reservation mechanisms, and others. Through a program of stakeholder outreach and a domestic and international best practices scan, this initiative documents the most relevant strategies for agencies in Virginia. These could be strategies geared toward heavily urbanized areas with existing high-capacity transit systems, to suburban locations with scattered low-density employment and housing, to college towns with high concentrations of tech-savvy riders, and to rural areas with aging populations.

Ultimately, transit is a major cog in the machinery of moving people and a critical link in the backbone of our economy. Transit coexists in a space often shared with many other travel options, but the potential exists to have these options complement each other. The transit industry will need to evolve to continue to serve its core functions, and this evolution may be challenging. Technology is at the heart of this evolution.

1.3 Stakeholder Engagement

This initiative included stakeholder outreach to the 21 largest fixed-route transit agencies in the Commonwealth. The list of stakeholders engaged includes the following (map is shown in **Figure 9** in **Section 3**, Virginia State of Play):

- Arlington Transit (ART)
- Bay Transit
- Blacksburg Transit
- Blue Ridge Intercity Transit Express (BRITE)
- Charlottesville Area Transit (CAT)
- City of Winchester
- DASH
- Fairfax Connector
- Fredericksburg Regional Transit (FRED)
- Greater Lynchburg Transit Company (GLTC)
- Hampton Roads Transit (HRT)
- Harrisonburg Department of Public Transportation
- Loudoun County Transit
- Petersburg Area Transit (PAT)
- Potomac and Rappahannock Transportation Commission (PRTC)
- Radford Transit
- Valley Metro
- Virginia Railway Express (VRE)
- Williamsburg Area Transit Authority (WATA)
- WMATA

Stakeholder outreach consisted of the following activities:

1) An **online survey**, responded to by more than 20 transit and transportation demand management organizations across Virginia, on stakeholders' understanding of shared mobility services and use of technology and data. These survey results are discussed further in **Section 3.3**.

2) A series of **webinars** with the stakeholders to discuss the project goals and objectives and to allow stakeholders to voice specific concerns and research interests

3) A statewide **Transit Technology Roundtable** discussion organized and sponsored by DRPT that took place in Charlottesville in September 2018

4) **ITS Deployment Plans** being updated and completed by each agency, detailing the 2018 status of existing and planned technology deployments. These include any

traditional ITS as well as shared mobility partnerships or pilot deployments. These deployment plans are discussed further in **Section 3.4**.

5) **In-person workshops** held in Northern Virginia, Charlottesville, and Hampton Roads in November 2018with stakeholders to discuss findings from the domestic and international state of the practice and preliminary recommendations for DRPT and the partner agencies

6) A **webinar** to present the final recommendations and implementation plan to stakeholders in early 2019

The remainder of the report is organized as follows:

- **Section 2** contains a summary of the state of the practice of integrated mobility. It describes shared mobility concepts, models, and partnerships. Domestic and international case studies are also included.
- **Section 3** summarizes the current state of play of integrated shared mobility and transit technology in Virginia. It includes results of a stakeholder survey and outreach and planned transit technology deployments of stakeholder transit agencies.
- **Section 4** documents recommendations and an implementation plan for DRPT based on the findings from the state of the practice and Virginia state of play
- **References** and **Appendices** are included at the end of the report

2. DOMESTIC AND INTERNATIONAL STATE OF THE PRACTICE

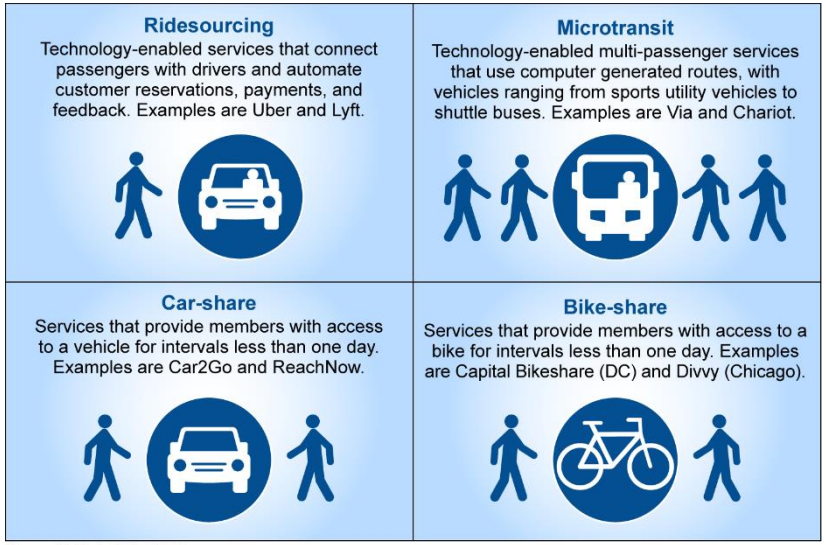
2.1 State of the Practice Summary

Mobility refers to the movement of people from one place to another for efficient and cost-effective access to employment, education, healthcare, and entertainment. Travel choices have large-scale, society-shaping impacts related to human rights, the economy, the environment, and the development of cities. Mobility in the U.S., once dominated by private vehicle use, is seeing changes due to the emergence of new travel modes, technological advancements, and social trends.

Cities and people have been encountering problems like increased congestion (reduced accessibility to important services) and costs to own and operate private vehicles. This has increased the pressure on public transit agencies to provide cost-effective services, particularly for those who may not own private vehicles. These challenges have encouraged development of several solutions including technological enhancements, policy changes, or innovative businesses models to provide better services to customers. At the same time, the rise of a sharing economy over the past decade has made new shared mobility modes available for solving mobility problems.

Connected travelers, continued advancements in transportation technologies, and private sector involvement present unprecedented opportunities for public transportation improvements. Concepts such as microtransit, mobility as a service (MaaS) and mobility on demand (MOD) have helped public agencies fill first and last mile gaps by developing and integrating unconventional modes into their services. This has included engaging the private sector in the form of transportation network companies (TNCs), carshare, bikeshare, and other modes as alternatives to private vehicles. The advent of app-based TNCs and ubiquitous mobile computing technologies has catalyzed changes in the transportation industry. The industry is moving towards expanding access to transportation modes on an as-needed basis, providing travelers with increased options for a customized trip that suits their specific needs.

While MOD and MaaS are often used interchangeably, MOD is focused on providing a technology platform that allows customers to incorporate some level of on-demand option into their transit travel and potentially discover, book, and pay for modes using the same user interface. MaaS is a similar



Source: GAO. | GAO-18-539

Figure 3. Shared Mobility Solutions (GAO, 2018)

concept that originated in Europe and incorporates all the elements of MOD but also involves integrating seamless payment and relevant infrastructure elements (e.g., parking and vehicle charging) to provide an attractive value proposition to customers using creative pricing and mobility packages.

Vehicle sharing companies (e.g., Zipcar, Lime, and Bird) and TNC/ridesourcing companies (e.g., Uber and Lyft) have leveraged their technical know-how and the demand for these services to change the way people travel, especially in urban environments. Ridesourcing companies have also

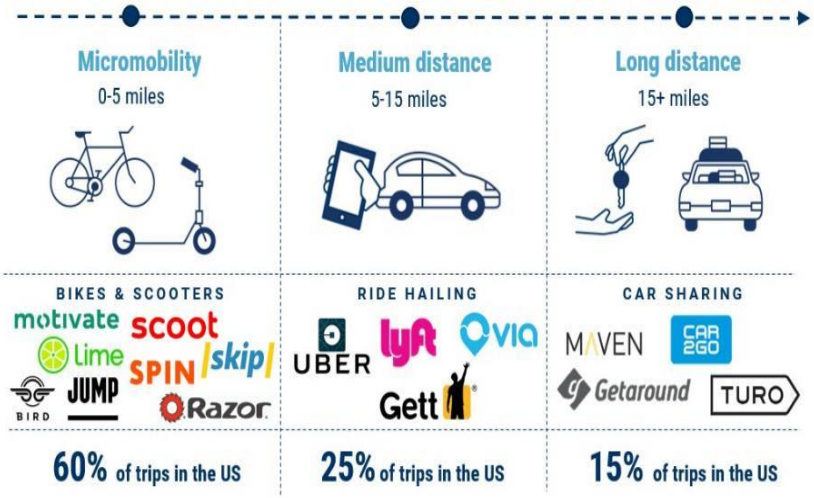


Figure 4. Shared Mobility Modal Split (CB Insights, 2018)

introduced the concept of a shared ride[2] (known as ridesplitting) in the form or UberPOOL and Lyft Line to provide more affordable travel alternatives to customers. Alongside ridesourcing and ridesplitting, public transit agencies have worked with the private sector to deploy microtransit platforms that serve real-time trip requests from customers. Given increasing influence of emerging technology trends on mobility options, mobility is now being seen as an information service with physical transportation products, rather than a transportation product with additional services (Ho & Bright, 2018).

New modes and service providers are making transit agencies rethink their role in the emerging mobility landscape. These changes have introduced new challenges, as discussed further in **Section 2.2.5**. Equity concerns continue to be the biggest hurdle for mass adoption of such platforms given the need for customer technologies (e.g., smartphone app-based tools and mobile payments attached with bankcards) and cost for services. Also, regulatory standards for drivers and vehicles vary significantly by jurisdiction. Finally, data privacy is a hurdle that is impacting data sharing among different providers. However, agencies realize the need for better on-demand transportation and are now taking on the role of "mobility managers" to ensure that equitable services are provided. An example of an agency moving towards this role is the San Francisco Municipal Transportation Agency (SFMTA) that has

[2] Shared ride is a broad concept and its definition is still evolving in the context of new shared mobility options. Recently released SAE J 3162-Taxonomy and Definitions for Terms Related to Shared Mobility and Enabling Technologies suggests that for-hire vehicle services should not be considered shared ride services even when pooled services are provided.

established its mission to "work together to plan, build, operate, regulate, and maintain the transportation network, with our partners, to connect communities."

With declining ridership in recent years, transit agencies have been exploring innovative ways to serve their communities while facing pressures to cut back on their regular fixed route services. Several agencies have partnered with TNCs to fill the gaps and some have established more efficient microtransit services. However, such shared mobility experiments are still in infancy, and there is no one-size-fits-all model. As shown in **Figure 4**, most trips taken by shared mode alternatives are for less than 5 miles and would mostly qualify as first/last mile connections and local mobility in the context of public transit use.

Section 2.2 elaborates in greater detail on the trends introduced in this section. Shared mobility solutions, service models, partnerships, and the accompanying challenges and opportunities for public transit agencies are presented.

Section 2.3 presents case studies of recent shared mobility implementations to illustrate the trends and the innovative ways transit agencies across the globe are adopting shared mobility practices. Domestic case studies focus on first/last mile services, autonomous vehicle pilot deployments, and TNC partnerships. International case studies focus on the MaaS concept and how governments are building infrastructure and regulations to offer better services by integrating modes.

Section 2.4 presents the state of the practice for other technologies used by transit agencies, such as on-board hardware and software, centralized technology systems to support on-board systems, and customer-facing technologies to disseminate information. These technologies serve indirectly to advance shared mobility and complement services described in the preceding sections.

2.2 Shared Mobility Concepts

Shared mobility refers to the use of shared vehicles, bicycles, or other modes. Short-term access to these transportation modes on an as-needed basis enables users to commute in a cost-effective way without taking complete ownership of the resource. The term also includes various forms of carsharing, bikesharing, ridesharing, and on-demand services.

A key advantage of shared mobility is its ability to fill gaps where traditional public transport is absent, inadequate, or ineffective. Lack of access to public transit is all too common in the U.S., especially for many low-income populations. Investment in high-quality mass transit in the U.S. lags far behind many other developed countries. Where the U.S. has a Rapid Transit to Resident Ratio[3] (RTR) of 8.9, France has a RTR of 30.2 due to continued investment in transit over several decades (Hook & Hughes, 2017). While improving mass transit in the U.S. is a long-term goal, shared mobility schemes can play a role connecting underserved populations to jobs, commerce, and recreation. Cities around the world are already starting to include vehicle sharing programs in their long-term planning. These cities recognize that connectivity is a crucial component to a vibrant, healthy city, improving economic growth and quality of life. Further, emerging trends towards smart cities focus on integrating shared mobility with

[3] RTR measures how many kilometers of mass transit exist in a country per million urban residents.

mass transit by creating strong intermodal connections to improve equity and access. Embracing shared mobility will also keep cities competitive at attracting residents and businesses.

2.2.1 Shared Mobility Solutions

Shared mobility solutions include shared vehicles (e.g., carshare, bikeshare, and scooter share), shared ride services (e.g., carpool and vanpool), ridehailing/ridesourcing (TNC), and microtransit services, as further explained in this section.

Vehicle Sharing (Cars, Bicycles, and Scooters)

Vehicle sharing services involve multiple customers operating the same vehicle at different times. While operating the vehicle, the customer has exclusive access. This is distinguished from more conventional car rental by generally shorter-term rentals and a distributed network of automated access vehicle storage, parking, or docking station locations. Customer eligibility may be public (i.e., guests are able to purchase a day pass) and/or private (i.e., long-term memberships that are only intended for locals and regular users).

Usage typically requires a means of identifying the user and securing collateral for the vehicle, such as a credit card. Vehicle sharing works best in areas with a sufficient user base within walking distance of the network of docking stations. Vehicle sharing may also enable first/last mile solutions if the density at the outer end of the trip is still sufficient to support a docking station. Industry examples include Zipcar, car2go, Capital Bikeshare, Lime, and Bird.

Ridesharing

Ridesharing is a software-assisted modernization of conventional carpooling in which drivers with their own personal vehicles are matched with passengers using the same subscription service to split the cost of commuting together. For security and payment management, eligibility as both a driver and a passenger is limited to members who maintain an account with the central service. Industry examples include Zimride, Getaround, Waze Carpool, and traditional carpool and vanpooling.

Ridesourcing

Ridesourcing, sometimes referred to as ridehailing, consists of a driver utilizing their personal vehicle to provide a private trip to a paying passenger. Unlike carpooling and ridesharing, the driver of a ridesourcing service is driving professionally and not making their own commute in the process of transporting passengers. Ridesourcing closely mirrors the service model of traditional taxis and is most familiarly employed by TNCs such as Uber and Lyft.

Microtransit

The U.S. Department of Transportation (USDOT) defines microtransit as "a privately owned and operated shared transportation system that can offer fixed routes and schedules as well as flexible routes and on-demand scheduling. The vehicles generally include vans and buses." Microtransit consists of medium capacity public transit vehicles (eight to 15 passengers) operating with on-demand, flexible routing to provide service to areas that are inefficient to serve with a fixed route. The driver operates as an employee of the transit agency or a corporation.

The distinguishing feature of microtransit compared to traditional demand response transit service is that the passenger does not need to schedule a trip far in advance—ordering trips can be done on-demand, and the centralized dispatching algorithm automatically adjusts service in response. Eligibility for microtransit service, as with conventional fixed route services, is open to the public, and fares may be integrated with the rest of the public transit network. Past attempts have been made by transit agencies to achieve this with traditional demand response scheduling and dispatch technology with limited success. Industry examples include Via and TransLoc.

Ridesplitting

Ridesplitting is a close counterpart of both the ridesourcing and microtransit models. The driver utilizes their personal vehicle, drives professionally rather than as part of their own commute, and can accommodate multiple independent passengers simultaneously (as distinct from ridesourcing that is oriented to an individual paying passengers) on a route that dynamically updates in response to new trip requests. Ridesplitting is another service offered by TNCs such as Uber and Lyft in major cities (UberPOOL and Lyft Line), where there is a higher likelihood of customers independently booking trips simultaneously, with start and end points that can be conveniently served using the same overall trip. Ridesplitting commonly uses lower capacity vehicles (less than six passengers).

These services are provided on-demand through MOD platforms, being enabled by private companies like Uber, Lyft, and others to facilitate first/last mile solutions, paratransit, and travel within low-density zones where it is not economically feasible to provide conventional transit services. MOD platforms, however, often provide only trip discovery options and access to a single mode. A recent push towards MaaS extends the technology platform to trip discovery for multiple modes, booking, payment, and real-time information through a single application. The Federal Transit Administration (FTA) in the U.S. has taken some steps in helping to promote shared mobility as well. FTA launched a MOD Sandbox program in 2016 to provide a venue through which integrated MOD solutions supported through local partnerships are demonstrated in real-world settings. TriMet's OTP-SUM project (Portland), BART Integrated Carpool to Transit Access program (San Francisco Bay Area), VTrans OTP (Vermont), and Dallas Area Rapid Transit First and Last Mile solution are some of the projects that fall under the MOD Sandbox initiative. **Figure 5 p**rovides a complete list of grantees and awarded projects.

The FTA MOD Sandbox projects are funded under FTA's Research, Development, Demonstration, and Deployment program authority, allocating a total of $8 million in October 2016. Researchers are currently assessing each of the 11 MOD Sandbox Program projects based on performance measures provided by the project partners in addition to an independent evaluation. FTA is anticipated to fund a second round of projects in 2019.

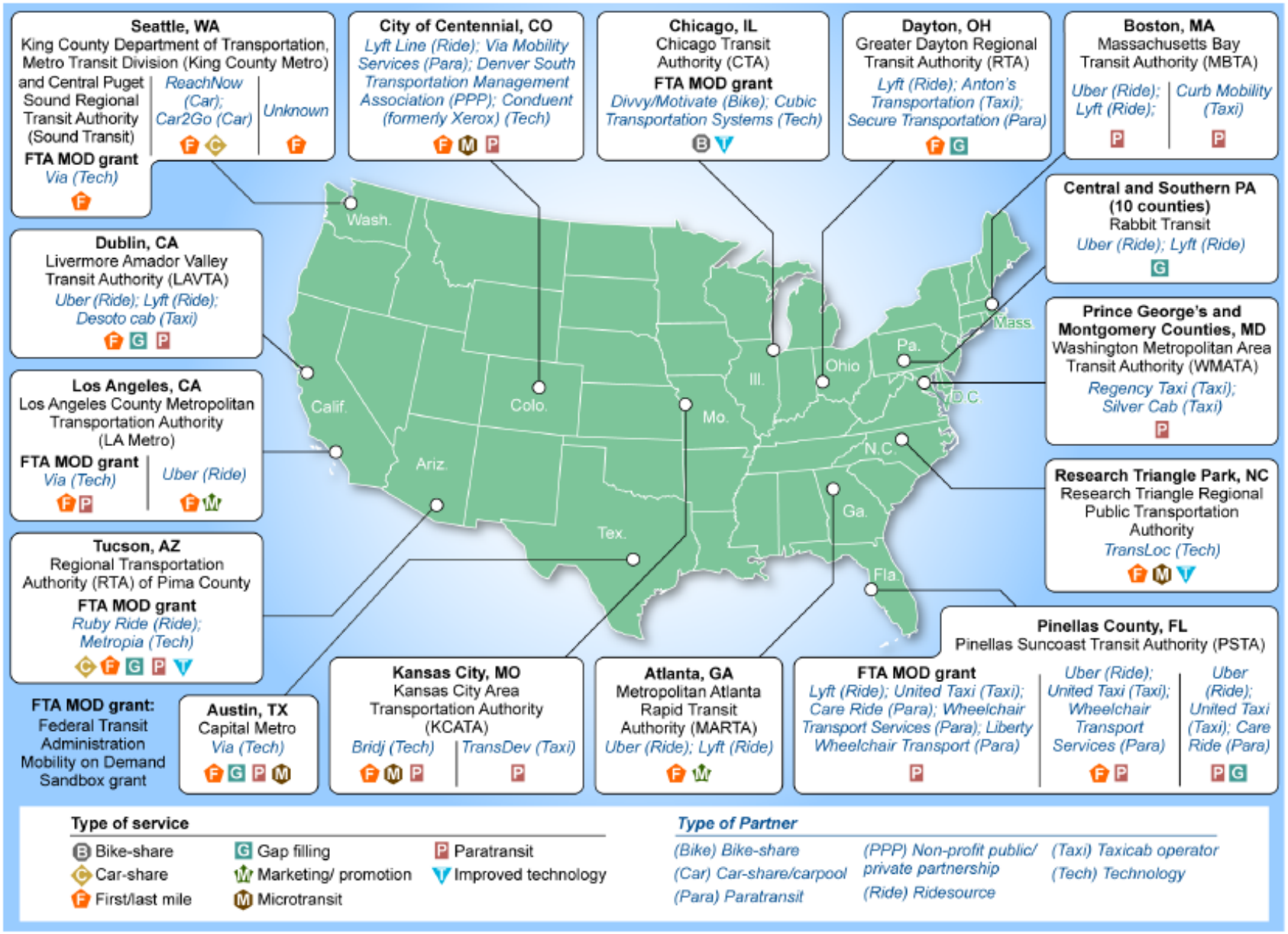


Figure 5. Mobility on Demand Sandbox Grantees (GAO, 2018)

Autonomous Vehicles

Connected and automated vehicles have had a strong presence as an emerging technology but with more activity related to personal automobiles and highways than transit. As the shared mobility ecosystem expands, DRPT recognizes the value of supporting pilots and programs for autonomous transit vehicles and innovative technology deployments with a variety of partner agencies in Virginia. DRPT will evaluate the performance of these pilots and programs to best identify resources and service models for implementation throughout the state and for partner agencies.

Some active pilot projects include the following:

Fairfax County Connected Autonomous Vehicle Shuttle Pilot Project – This project will look at developing a proof of concept for a first/last mile connection from a WMATA metro station to a mixed-use development with potential to expand service into a medical campus in later phases. This will be one to two self-driving autonomous shared-ride shuttles between the Dunn Loring metro station and the Mosaic District. This pilot aims to demonstrate the value of first/last mile connections and observe public opinion on automation in transportation. Major partners and stakeholders include Dominion Energy, Virginia Department of Transportation (VDOT), Fairfax County Department of Transportation, and DRPT.

Northern Virginia Regional Commission/Joint Base Myer-Henderson Hall (JBM-HH) Olli Fleet Challenge in Arlington – LM Industries Group Inc. and its subsidiaries Launch Forth and Local Motors launched its autonomous fleet challenge in September 2018, inviting municipalities, campuses, and designated districts to propose a 3-month, local use for Olli, their low-speed electric shuttle. The JBM-HH, located in eastern Arlington County adjacent to the Arlington National Cemetery, with the Northern Virginia Regional Commission (NVRC) will submit an entry for the challenge with the JBM-HH serving as a pilot test-site for the challenge. Phase I of the challenge will include two Olli vehicles along with maintenance, training, and technical support in an urban setting while staying within the base boundaries. If Phase I is successful, Phase II will integrate both JBM-HH and the Pentagon to provide expanded service and testing. Stakeholders for this challenge include JBM-HH, VDOT, DRPT, Virginia Tech, and Washington Metropolitan Council of Governments among others.

Statewide procurement for Mobileye Shield+ Driver Assistance System and Demonstration Project – Initiated in December 2017, DRPT executed a statewide procurement contract with Rosco Collision Avoidance Inc. to secure a pedestrian collision avoidance system that could be retrofitted to existing transit vehicles and provide operators real-time alerts on pedestrians and bicyclists in the transit vehicle's forward facing blind spots. These systems include a heads-up display (HUD) that provides varying scales of audio and visual alerts to assist the operator in improving safety and operations of the vehicle. DRPT also started a demonstration pilot for 50 transit vehicles throughout the Commonwealth to test and evaluate the effectiveness of the Mobileye Shield+ system in a variety of geographic service areas and fleet sizes. Nine transit agencies submitted Statements of Interest to participate in the demonstration project and installation and training for the systems are still underway.

Other industry examples of automated vehicles in transit include pilot projects in San Ramon, CA; Columbus, OH; Austin, TX; Las Vegas, NV; and Chandler, AZ.

DRPT has joined a national consortium for the investigation of the joint purchase of a 40-foot automated bus for potential deployment in the Commonwealth of Virginia in cooperation with other national transit agencies. This consortium includes several elements including a technology assessment, an autonomous bus deployment program, the consortium of transit agencies, and a goal of deployed technology by 2021/2022 in multiple applications.

The work program for DRPT's participation in the consortium is divided into two major phases: a general solicitation up to three pilot projects with Virginia-based entities to partner with DRPT to investigate the potential to deploy 40-foot automated buses in their local jurisdictions and a Preliminary Development Agreement (PDA), which involves participation with other transit agencies from around the country to define the selected deployment location for each participating agency, operating plan, bus specification, industry forum, financial plan, and deployment plan. At the end of the second phase, agencies will decide whether to continue with the purchase and deployment of automated buses or they can terminate their involvement in the program. The agencies that decide to continue will be participants in a third phase (called Comprehensive Development Agreement – CDA) of implementation. Additional agencies could be added after the PDA Phase with appropriate financial contributions. DRPT and Hampton Roads Transit (HRT) have elected to partner together for the AECOM Automated Bus Consortium and is currently working with AECOM to identify candidate pilot routes for consideration.

2.2.2 Shared Mobility Service Models

Fundamentally, shared mobility services can be categorized into the following five service models as also shown in **Figure 7**.

1) **Membership-based self-service models** – Require customers to sign up for a monthly or annual membership for using the service (e.g., Zipcar)

2) **Peer-to-peer (P2P) self-service models** – Enable transactions between individuals; this differs from membership-based models in the sense that assets are owned by individuals instead of business entities (e.g., Turo)

3) **Non-membership self-service models** – Do not require any membership (e.g., car rental and casual bikeshare)

4) **For-hire service models** – Apply to customers booking a service, often offered by a private entity, on-demand by phone or website for a fare amount that is predetermined based on distance or time or is dynamically priced

5) **Mass transit systems** – Multimodal services, generally offered by a public entity, that are designed to carry large groups of people

Figure 7. Shared Mobility Service Models (Susan, Cohen, & Zohdy, 2017)

2.2.3 Shared Mobility and FTA Definition of Trips

FTA's definition of public transit modes includes fixed route and demand response services. Deviated fixed route services, as shown in **Figure 6**, are reported as the bus mode. However, shared mobility options are not clearly defined under FTA's definition of trips. The purpose of this diagram is to relate shared mobility options with existing services that transit agencies operate per the statuary definition of trips by the FTA.

Also, reporting of trips to the National Transit Database (NTD) by agencies currently does not account for any of the trips taken by shared mobility options since the NTD definition of trips

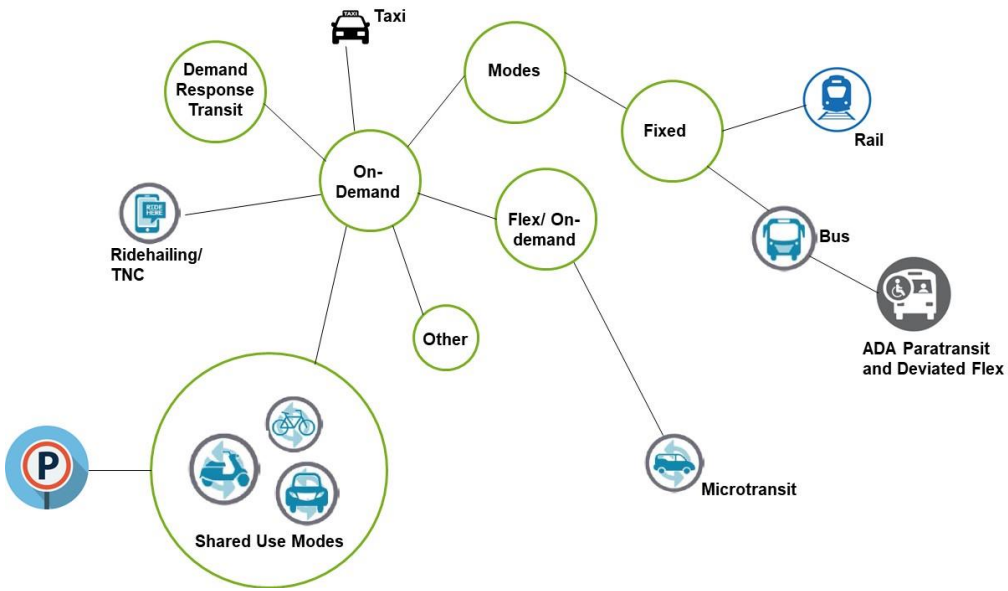


Figure 6. Shared Mobility Trips in the Context of FTA Definition of Modes (IBI Group, 2018)

does not fit the current classification. A report on Public Transit Partnerships published by the Government Accountability Office (GAO), dated July 2018, highlights similar concerns when most grantees of the MOD Sandbox project were not sure on reporting shared mobility rides to the NTD. The report also distinguishes that shared ride services reported to the NTD are for services that are "open to the general public" which may not be the case with services operated by private entities such as TNCs and others. Also, NTD provides agencies an option to not report services operated by their contractor, depending on the terms and conditions of those contracts.

Using federal funds to pay for some of these services is also subject to further review. While agencies may be able to use federal funds, those funds should be used for shared-ride service, not exclusive-ride service, while equivalent levels of service are provided to people with disabilities. There is a need for FTA to provide further guidance on how shared mobility trips should be defined under the current public transportation statute and requirements for private entities to report data on services provided.

2.2.4 Types of Shared Mobility Partnerships with Public Transit Agencies

Transit agencies can help shape the future of urban mobility while enhancing service for their customers by partnering or integrating with mobility solution suppliers. Municipal governments, transit agencies, and metropolitan planning organizations across the globe are realizing that a synergy between TNCs and transit agencies could enhance mobility at a reasonable cost. Most partnerships are formed to help riders in underserved areas or where supply of parking is insufficient. Agencies are partnering with TNCs and other service providers in different ways to offer better equitable services and acquire data on ridership. In turn, they plan their services using the data. Partnerships tend to fit into the following categories:

First/Last Mile Service Connections

The first mile refers to the leg of a trip between a person's origin (e.g., home) and a transit stop where the person boards a transit vehicle; the last mile refers to the leg of a trip between the transit stop where the person alights the transit vehicle and the destination (e.g., work). First/last mile partnerships leverage TNC services to connect customers to transit service that is inconvenient to get to instead of foregoing transit altogether. The customer pays a lower overall fare than the cost of a TNC-only trip, and both the TNC and transit agency serve more passengers. The Pinellas Suncoast Transit Authority (PSTA) in Florida, created the Direct Connect program with Uber and United Taxi to partially subsidize trips (up to $3 off the total cost) going to/from designated bus stop zones during a 1-year pilot. PSTA estimated the Direct Connect partnership would save the agency $70,000 compared to the cost of providing a fixed-

TRANSIT AGENCIES CAN HELP SHAPE THE FUTURE OF URBAN MOBILITY, WHILE ENHANCING SERVICES FOR THEIR CUSTOMERS, BY PARTNERING OR INTEGRATING WITH MOBILITY SOLUTION PROVIDERS

route service in the partnership area (Moran, Ettelman, Stoeltje, & Hansen, 2017).

Gap Service

Gap service partnerships address the challenges of providing adequate and cost-effective transit in areas with low population densities. Faced with this issue, transit agencies sometimes reduce service frequency outside of central business districts and on nights and weekends. In TNC/transit gap service partnerships, TNCs provide transit-like service for customers in a designated zone. The transit agency subsidizes the trip fare because of the potential to save on operating expenses by using TNC vehicles and drivers rather than a transit vehicle.

The Kansas City Area Transportation Authority (KCATA) created a 1-year program called RideKC: Bridj, a partnership providing on-demand service within and between two service zones of the city. Bridj, although no longer in business, provided microtransit service with smaller buses rather than drivers with personal automobiles. All trips in the service zones cost a $1.50 fare for the customer, equal to the regular local regional bus fare. KCATA subsidized the rest of the cost to Bridj through funds of about $1.3 million in sales taxes. The RideKC: Bridj pilot concluded in spring 2017 with 1,480 total rides, lower than originally projected (Shaheen, Stocker, Lazarus, & Bhattacharyya, 2016).

Promotional Fares and Marketing Services

Promotional partnerships are designed as temporary programs to encourage people to begin using TNC services to connect to transit on a regular basis or during large events. Some partnerships have used subsidized fares or a free TNC trip promotion to announce a new rail/bus service opening or to make people aware of available travel options during a special event, such as the following:

- In October 2016, Sacramento Regional Transit in California partnered with Lyft, Uber, and Yellow Cab to create the Station Link Program, offering $5 TNC fares to specific transit stations up to the first 10 trips for the individual user. The program was funded by a $50,000 grant from the Sacramento Metropolitan Air Quality Management District (Descant, 2018).
- A unique partnership was formed between Metra in Chicago and Uber in December 2014. This 3-year agreement made Uber the official rideshare partner of Metra. The agency generates non-fare revenue from the partnership and displayed Uber's name on promotional materials throughout its locations, vehicles, and marketing channels (Wisniewski & Lee, 2016).

Special Populations and Paratransit Services

These programs seek to take advantage of the cost-effectiveness of ridesharing while providing greater convenience for those with mobility challenges. The Massachusetts Bay Transportation Authority's (MBTA) pilot program with Lyft and Uber is among the largest programs launched in coordination with TNCs. The program provides eligible residents like seniors and the disabled with alternative services in the form of a certain number of rides at subsidized rates per month. Users of UberX and Lyft pay the first $2 and any amount above $42 (arrangements for other services vary slightly). Riders enjoy faster pick-ups at usually lower prices than with MBTA's existing paratransit service (RIDE) (Schwieterman & Livingston, 2018).

Las Vegas, NV, provides subsidized Lyft rides to paratransit-eligible riders who pay $3 one-way fares. A motive for this program is to alleviate the $32 per ride cost incurred by the city for traditional paratransit services. The city estimates its cost for each rideshare is about $15 per ride. (Lam & Liu, 2018).

Technology Integration and Data Sharing

Some partnerships connect transit agency customers to TNC services through a common mobile app platform by using application programming interfaces (APIs). An example is a customer using a transit agency app to book a TNC trip and pay the fare, helping the customer complete the remainder of the journey to the destination more easily. Dallas Area Rapid Transit (DART) in Dallas, TX, entered into partnerships with Lyft and Uber to allow riders to pay for TNC rides through DART's GoPass mobile ticketing application. DART received federal funding to expand GoPass connections to TNCs with the goal of improving first/last mile connections (Moran, Ettelman, Stoeltje, & Hansen, 2017) (Ho & Bright, 2018).

Anaheim Resort Transportation (ART) will also be launching its own mobile app that will host a variety of services from TNCs, car rentals, and resort and theme park tickets in 2019. The app is developed by Routematch, a transit technology provider based in Atlanta, GA, as a part of a public-private partnership. The development costs and contracts with other service providers are being managed by Routematch and the transit agency is only responsible for marketing the app. This lets the transit agency focus on its core services and provide better service to the customers while Routematch focuses on the technology for the mobile app and third-party integrations.

2.2.5 Challenges and Opportunities

A public agency considering contracting or otherwise coordinating with a private entity for the provision of transportation service must navigate a number of potentially tricky regulatory standards and public perception issues. With the advent of Uber service in 2009 and Lyft service in 2012, the world of transportation has changed dramatically, but the associated regulatory framework has not kept pace. Several recent studies published by the Transit Cooperative Research Program and the FTA have provided some guidance on how they will view new services. These new services and contractual arrangements have not been tested in the legal system.

With further changes likely to result, the sections below provide guidance on issues that may arise and how best to deal with concerns in the current environment. Most of the discussion applies to Uber and Lyft, but similar considerations would exist for partnerships with any private company.

Equity and Title VI

A principal concern is to ensure that any new service arrangement with a private company meets all requirements related to equity. Equity in this sense encompasses:

- **Service availability** – Where and when service is provided
- **Fare** – How much is charged to use the service
- **Technology access** – Ensuring that riders have access to the service without requiring a smartphone

- **Rider access** – Non-discrimination based upon rider characteristics, including Americans with Disability Act (ADA) and Title VI of the Civil Rights Act

Equity does not mean equal or the same but rather the same end result regardless of the above list. For example, a transit agency may establish geographic zones where a private operator provides the service, and the service in that zone may be a different type of service than is offered elsewhere. In an area of low demand, where traditional fixed route service is unproductive, a transit agency could contract with Uber or Lyft to provide demand-response service. Or, such services could be provided only late at night when traditional demand decreases. To arrange this with equity, the transit agency would need to ensure that such an arrangement was not done in a discriminatory fashion, such as only offering the service in low-income or minority communities.

The fare charged for the service would have to be equitable when viewed against the fares charged for a traditional fixed-route service, adjusted for differences in the type of service provided. For example, federal law states that fares for ADA riders shall not exceed twice the fare that would be charged to an individual paying full fare for a trip of similar length at a similar time of day (49 CFR §37.131). However, these laws were established when ADA service was generally demand-response and was being compared with fixed-route, general-public services. It is unclear whether a larger difference could be charged for a TNC-type service that was offered to the general public.

There is also concern regarding whether a rider must have a credit/debit card account rather than being able to use cash. A ticket vending machine (TVM) overcomes some of this limitation if they can be placed near where riders board; however, it is impractical to provide full coverage for a demand-response service with widely dispersed origins and destinations. In addition, currently neither Uber nor Lyft accept cash or ticket fares.

Account-based fare collection technology is an opportunity for enhancing integrated payment options. These systems allow customers to maintain an account that they can fund with a bank card or other methods (e.g., paying by cash in-person at retail locations). At the same time, agencies can work with third-party solution providers to build links with shared mobility service provider apps, so customers can pay for their trips when they book or when trips have been completed. Account-based payment also allows agencies to partner with local retailers to sell passes and other fare products through electronic media (e.g., prepaid cards and loading agency smartcards) to customers that may be unbanked.

Technology access is another equity concern. The Pew Research Center has tracked the prevalence of cell phones and smart devices among different population groups. Overall, they found that in the U.S., 95 percent of individuals own a cell phone of some type, with 77 percent owning a smartphone. This widespread adoption indicates that technology access may decline as a consideration over time, but the report did identify some areas of concerns. Notably, older individuals (65+) were less likely to have a cell phone (85 percent) or a smartphone (46 percent). People with less than a high school education were less likely to have a smartphone (57 percent) as were lower income (less than $30,000) individuals (67 percent). Rural residents were also less likely to have a smartphone (65 percent). These results are at a national level;

further differences may exist at an individual location (Pew Research Center, 2018).

Equity is also an issue when it comes to the treatment of individual riders. This issue is primarily a concern when it comes to how an individual driver may treat an individual rider, such as an Uber driver refusing to serve someone from a protected group. Both Uber and Lyft have guidelines for their contractor drivers that prohibit such discrimination and even go beyond federal laws by prohibiting discrimination based upon sexual orientation, marital status, and gender identity, which are not covered by federal statutes. Engaging in such discrimination will result in the driver being barred from driving for the company.

Driver Training, Screening, and Hours of Service

The safety of the service provided is a paramount concern to a transit agency. Safety relates to both the safety of the driver (discussed here) and the safety of the vehicle (discussed in the next section).

The Federal Motor Carrier Safety Administration (FMCSA) has established several regulations to ensure that drivers are able to safely operate their vehicle. One area of regulation is the "hours of service"; that is how many hours a driver can safely drive before taking a rest break. For interstate commerce (where federal regulations apply), related to a vehicle that carries nine or more passengers including the driver, there are three hour-of-service limitations. First, a driver cannot be on-duty for more than 15 hours without taking 8 hours off. Second, a driver cannot drive for more than 10 hours without taking an 8-hour break. Third, a driver cannot be on-duty for more than 60 hours during any consecutive 7-day period or 70 hours during any consecutive 8-day period. While these regulations apply only to interstate commerce, most states have similar legislation (Federal Motor Carrier Safety Administration, 2014)

What's notable about the above regulations is they apply to drivers who operate a vehicle that carries nine or more passengers. Most Uber and Lyft vehicles are private cars that carry five to seven people, so these regulations do not apply. Uber and Lyft have recently imposed their own hours-of-service limits—Lyft requires drivers to take a 6-hour break for every 14 hours the driver has the app in service; Uber requires a driver to take a 6-hour break after 12 hours of "driving time." Driving time equals the time the driver has the app in service, less time spent stopped between trips. While these regulations are an attempt to mimic the federal hours-of-service rules, nothing prevents an individual driver from far exceeding these service hours by switching back and forth between the apps.

In order to drive for either Uber or Lyft, drivers must pass a background check. Neither company reveals precisely what the checks encompass, but they cover a motor vehicle record review and a criminal background check. Uber notes that it periodically reruns background checks. Generally, a driver is declared ineligible if they exceed a certain number of traffic violations or have a felony, violent crime, or sexual offense for both companies and drug-related offense or certain theft or property damage offense for Lyft. These requirements may not be as strict as the public agency puts on its operators. For example, neither company does a fingerprint check as do some taxi licensing boards. Note that neither Uber nor Lyft does any drug screening, whether pre-employment, periodic, or for-cause. Instead, both companies rely on their rating system to identify problem drivers. A rider is encouraged to report

suspected under-the-influence driving and the company will follow up.

Neither Uber nor Lyft does any training for their drivers, although Uber does note that some drivers that have been removed from driving can have their privileges reinstated if they complete some training. There is no general operation, safety, or customer interaction training. Instead, these companies rely on the "community guidelines" and rating system to identify where a driver may have a problem. Taxi license boards have differing requirements depending upon the city.

Vehicle Standards

Vehicle standards are important from a safety and accessibility perspective. From a safety perspective, all vehicles must pass the annual state inspection standards, whether owned by a private individual (for Uber and Lyft), a taxi company, or a bus owner. Uber and Lyft further place age limits on their vehicle. A vehicle can be no older than 10 or 15 years depending upon the company and location. Neither company conducts in-person vehicle tests, instead relying on the annual state inspections to ensure the vehicle is safe to operate. For non-safety issues, such as body or interior damage, the companies rely on riders to report issues.

Neither Uber nor Lyft have a requirement to operate an accessible vehicle. Both companies' guidelines require a driver to accept wheelchair passengers if their wheelchair can fit into their vehicle. This lack of an individual vehicle being accessible is not a problem for the FTA, assuming that some mechanism exists to provide an equivalent level of service to the rider. As a practical matter, this burden would fall on the public transit operator to be able to dispatch an accessible vehicle when needed. A potential issue is that the accessible service must be "equivalent" to the service provided to those without disabilities—including response time. It is unclear from FTA guidance how this would work if an accessible vehicle is dispatched from a remote facility while non-accessible vehicles are prevalent throughout a community.

Prevailing and Minimum Wage

Special requirements relate to the wages and benefits of mass transit employees. According to the U.S. Department of Labor:

> When federal funds are used to acquire, improve, or operate a mass transit system (public transportation), federal law requires arrangements to protect the interests of mass transit employees. 49 U.S.C. § 5333(b) (formerly Section 13[c] of the Urban Mass Transportation Act). Section 5333(b) specifies that these protective arrangements must provide for the preservation of rights and benefits of employees under existing collective bargaining agreements, the continuation of collective bargaining rights, the protection of individual employees against a worsening of their positions in relation to their employment, assurances of employment to employees of acquired transit systems, priority of reemployment, and paid training or retraining programs. 49 U.S.C. § 5333(b)(2).

This could potentially be an issue if any current operator jobs are replaced by lower-wage jobs, especially if the replaced jobs were covered by a collective bargaining agreement.

In the case of using Uber and Lyft, the hourly wage will inevitably be lower than the wages paid to unionized operators. While little data exists on the earnings of Uber and Lyft drivers, the drivers must pay all expenses (gas, maintenance, and insurance) out of their earnings, so their effective hourly rate is dramatically lower, perhaps even less than the federal minimum wage. According to a recent study conducted by MIT's Center for Energy and Environmental Policy Research (CEEPR), Uber and Lyft drivers earn a median wage of $3.37 per hour. While Uber has contested this finding by claiming the average gross earning is closer to $20 per hour and MIT is revisiting the research methodology, such low wage is considerably lower than what transit drivers typically earn, particularly accounting for other benefits they also receive as agency employees (U.S. Department of Labor. Mass Transit Employee Protections, 2018).

Private Sector Competition and Charter Regulations

Public bus companies are prohibited from providing charter service in competition with private charter bus companies. In general, these regulations prevent FTA subsidized grant recipients from unfairly competing with private companies.

The FTA website specifically notes that these regulations do not apply to demand-response service to individuals, so they would not apply to any TNC-type services. They could potentially come into play if a transit agency looked at establishing its own service in competition with a microtransit-type operator that provides a customized route for select companies or groups of individuals.

Private Partner Durability

In the past, a transit operator faced the downside risk that its private partner could go out of business. This risk could be controlled by partnering with more than one taxi company, for example, or by owning its own vehicles which would be operated by a private bus company. If the private bus company went out of business, the public transit operator would be able to reclaim its equipment for use by a new contractor in a short amount of time.

For the newest mobility companies, whether bus-based, such as Bridj, or private-car based, such as Uber and Lyft, the risk is greater. Bridj has already ceased operation, and Uber and Lyft face challenges to their business model. Already in Europe, Uber has been classified as a *taxi company*, which subjects it to additional regulation, including having to classify its drivers as *employees* rather than *independent contractors*. Should that occur in the U.S., Uber and Lyft's cost of operation will dramatically increase as they will now have to offer benefits to their employees and ensure they meet minimum wage standards.

Data Sharing, Privacy, and Standardization

It is critical for local and regional governments to develop best practices that identify data standards and balance data sharing (open data) and privacy among individuals, companies, and public agencies. Public and private partnerships to standardize data, share data, and protect sensitive data can be key to understanding shared mobility's impact on the transportation network and encourage

innovation. Shared mobility operators typically track several important data points—the origin and destination of shared services (e.g., the pickup and return location for a carsharing or bikesharing vehicle or ridesourcing passenger), travel time, and trip duration. A number of shared mobility service providers have shared data with public agencies either voluntarily or as part of a regulatory mandate. For example, as part of Washington, D.C.'s carsharing parking initiative adopted in 2005, carsharing operators seeking on-street parking are required to provide the District Department of Transportation with quarterly data to assess the impacts of their parking program. In 2012, City CarShare voluntarily shared data with the SFMTA during the city's SFpark pilot to assist planners and policymakers with the development of the carsharing parking policy.

PUBLIC AND PRIVATE PARTNERSHIPS TO STANDARDIZE DATA, SHARE DATA, AND PROTECT SENSITIVE DATA CAN BE KEY TO UNDERSTANDING SHARED MOBILITY'S IMPACT ON THE TRANSPORTATION NETWORK AND ENCOURAGE INNOVATION

Given growing partnership between TNCs and public agencies, California and a number of municipalities in the U.S. have developed regulations that require data sharing from TNCs. The California Public Utilities Commission (CPUC) is the state agency that regulates TNCs in California. CPUC requires TNCs to provide six data-sharing reports each quarter. These reports are primarily for enforcement purposes, and CPUC does not share any data with municipalities or the general public. The six reports required by CPUC include data about:

- Provision of vehicles providing services to disabled persons
- Service provision by zip code
- Problems reported about drivers
- Hours logged by driver
- Miles logged by driver
- Drivers completing a driver training course

Also, in response to continual requests for TNC-generated data, Uber has developed a website called Uber Movement, which provides the company's trip data (excluding any details on origin and destination info). It provides anonymized and aggregated data by geographies such as census tracts and traffic analysis zones.

In addition to this data sharing with public agencies, a number of shared mobility service providers make data publicly available for download. Bay Area Bike Share, Capital Bikeshare, and Citi Bike are a few of the operators that provide some of the most expansive publicly available data, including information on trip origin and destination (location and time); rider type (e.g., the type of user pass); home zip code for annual members; the bicycle number; weather information; and bicycle/dock availability at each station. Real-time data on service availability are becoming increasingly available for shared mobility modes. Operators are making these data available on their websites and apps for users and non-users to

locate services, such as available bikesharing bikes, open docks, and idle carsharing vehicles. In addition to providing these data on operator websites, the use of APIs is increasingly creating an open data infrastructure with third parties, such as aggregator and trip planning websites and smartphone apps.

Furthermore, similar to General Data Protection Regulation (GDPR) in Europe, individual states in the U.S. have started to take the lead in developing and implementing data privacy laws. As of September 2018, only California has comprehensive data privacy laws in place in form of California Consumer Privacy Act (CCPA) of 2018. Vermont also provides greater protection and requires data "brokers" to register with the state, implement security provisions, and provide annual reports. Other states currently provide legal protection only against security breach of consumer information, specifically for personally identifiable information (PII).

2.2.6 Role of Transit Agencies and Regulating Bodies

As agencies are evolving and adapting to different kind of services being offered, one of the most common partners of shared mobility are local and regional governments because of their role in transportation planning, public transportation, and parking policy. Congestion mitigation, air quality improvement, and parking management have been long-time goals of local governments. In recent years, climate action planning has further raised the awareness of shared mobility among local governments.

Agencies are trying to offer better services by integrating these services into their planning. Based on developments in this space, six areas of focus have been identified which agencies are considering as they experiment and plan for the future (Susan, Cohen, & Zohdy, 2017).

Health, Safety, and Consumer Protection

Local, state governments and public agencies have established administrative regulations, ordinances, and laws that may require insurance, driver physicals, and/or the disclosure of factual information to provide transparency about services and/or prevent the dissemination of inaccurate or misleading information. Another important consumer protection is policies that ensure access to services. Pricing regulations, access laws, and insurance laws are some areas where governments can help the shared mobility landscape.

In terms of regulations, each state has its different laws for TNCs and other partners of shared mobility. For example, 42 states require TNCs to have a background check conducted for a TNC driver before or within a specified amount of time after that driver is allowed to operate. State TNC legislation varies in terms of who conducts the background check, what databases are reviewed, and what disqualifies a driver from work eligibility. However, no state law currently requires fingerprint-based background checks for TNC drivers. Uber and Lyft have opposed fingerprint-based background checks on the grounds that their third-party background checks are safe and reliable; both companies have suspended service in most locations where a fingerprint requirement has been imposed. Ultimately, no background check process can guarantee that an individual will not commit a crime in the future. Other focus areas which have been highlighted by previous deployments are vehicles inspections, driver training and limitations on driver working hours.

Taxation

The role of tax incentives and taxation on shared mobility, such as rental car excise taxes, sales taxes, and commuter tax breaks, is a challenging issue for local authorities. Unclear definitions and service models among shared mobility services, such as carsharing, ridesourcing, taxis, and rental cars, have led to confusion among state and local governments about taxing these mobility services. Rental car taxes have been particularly popular among politicians because the taxes were believed to target visitors, not voters. Governments can help encourage the industry by creating supportive taxation, like how in 2005 Chicago eliminated the e8 percent Personal Property Lease Transaction Tax on carsharing rentals less than 24 hours in duration. The city defined carsharing as a membership-based organization providing self-service access to vehicles with inclusive insurance and no written agreement required per rental period.

Additionally, taxation of ridesourcing has emerged as a key issue in numerous international jurisdictions. Services, such as Uber, have been the target of tax probes in areas like Belgium and India because these users pay through a Netherlands-based Shell Corporation, Uber BV, and avoid paying local taxes. In March 2015, India's Finance Ministry amended its 2015 to 2016 tax rules establishing an "aggregator model" characterization to tax e-commerce services, such as Uber and Trip Advisor.

Insurance

Insurance limits and requirements for shared modes are key problems for state, local, and regional governments, particularly among P2P vehicle sharing and on-demand ride services. The average cost of insuring a carsharing vehicle has fallen to an average of $789 per vehicle. Even for P2P services, there are not many provisions specific to these services in state legislation. The issue with P2P would be to determine where the vehicle owner's policy ends and when the P2P carsharing operator's commercial policy begins. Personal vehicle sharing programs assume liability when the vehicle is rented in a shared capacity, and the owner's insurance policy resumes coverage once it is returned. Vehicle owners who share their autos in states lacking personal vehicle sharing legislation risk non-renewal of primary insurance policies as well as premium spikes resulting from increased use.

In addition to carsharing and P2P carsharing insurance, owners and operators of bikesharing programs can be sued if one of their bicycles is involved in a serious collision resulting in injuries, fatalities, or property damage. Like carsharing, bikesharing owners and operators can manage risk and limit their liability by signing waivers or indemnification clauses, keeping equipment well maintained, and educating users about bicycle and roadway safety. Unlike rental cars and carsharing, bikesharing programs do not have statutory protections against vicarious liability. Also unlike rental cars, bikesharing users do not have the ability to purchase insurance at the time of a mobility transaction. As such, the user and the bikesharing operator may be held responsible for the conduct and damages associated with their program's equipment.

A case in California sets an example as the first public agency to define TNCs. It defines them as "a company that uses an online enabled platform to connect passengers with drivers using their personal, non-commercial vehicles." CPUC established a number of requirements for legal operations for TNCs operating in California including:

- AB2293, which took effect on July 1, 2015, supplemented CPUC's insurance requirements mandating period insurance coverage. The law requires TNCs maintain primary third-party insurance coverage in the amounts of $50,000 per an individual with a total of $100,000 per accident along with up to $30,000 for property damage.
- Maintaining $1 million in liability coverage when the driver is en route for pick-up and when the rider is being transported, along with contingent liability coverage of up to $100,000 once the driver has turned the app-on
- Obtaining a CPUC license to operate
- Having each driver undergo a criminal background check
- Establishing a driver training program
- Implementing a zero-tolerance policy on drugs and alcohol
- Conducting a 19-point vehicle inspection
- Obtaining authorization from airports before conducting any operations on airport property or entry into any airport

Figure 8 below illustrates the different insurance hand-over scenarios.

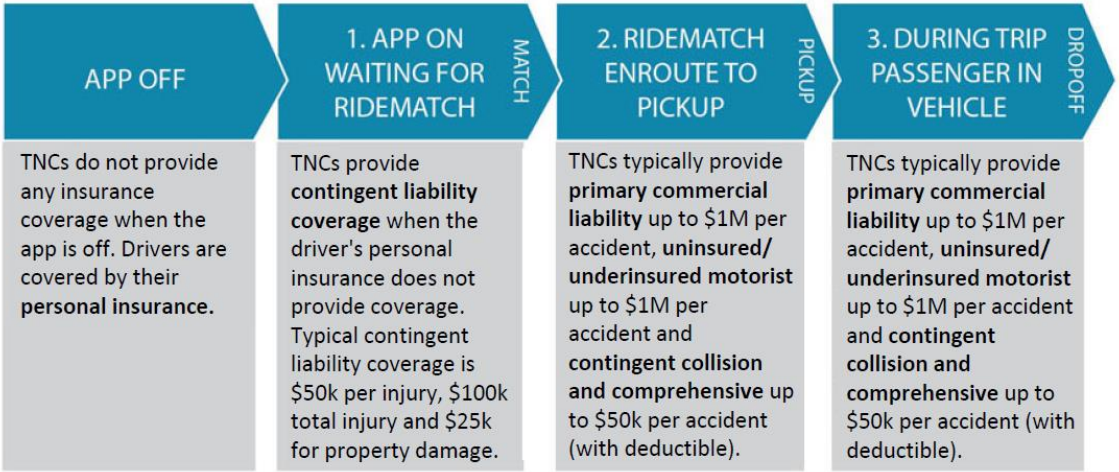


Figure 8. Insurance Handover Scenarios (Susan, Cohen, & Zohdy, 2017)

Parking and Access to Rights-of-Way

Local and regional governments have been addressing the key issue of managing on-street curb space for shared modes, including equity issues pertaining to the use of public space for a private business or non-profit purpose as well as competing operators and modes. The allocation of parking and rights-of-way remains a key issue. In the early years of shared mobility, on-street carsharing parking was a priority. Philadelphia, PA; Portland, OR; Vancouver, British Columbia; and the State of California represent some of the early pioneers of policies related to parking and rights-of-way. Increased competition among operators and modes for on-street and public space, coupled with the expansion of shared mobility into innovative service models, such as carsharing, public bikesharing, and high-tech company shuttles, has created the need for new policies to address a different set of challenges.

Signage and Advertising

Local authorities play a key role in regulating the signage and advertising of shared modes. In roundtrip carsharing, there are numerous examples of parking policies. For instance, Portland,

OR, developed the "Option Zone," which is a carsharing parking space designated by an orange pole and attached bicycle rack that can be mounted to parking meter heads and curbs. Philadelphia, PA, developed its own on-street parking policy for carsharing, initially granting on-street parking to non-profit operators only. Philadelphia was the first jurisdiction to distinguish between for-profit and non-profit carsharing operators. Vancouver, British Columbia, developed one of the earliest universal parking permits, dedicating a permit for carsharing vehicles (in contrast to a parking spot). The universal permit enabled carsharing members to park a carsharing vehicle in all 19 of the city's parking zones. Although designed for roundtrip carsharing, Vancouver's policy set the stage for similar universal parking permit policies, enabling free-floating one-way carsharing.

In the U.S., the majority of public bikesharing kiosks are located in the public right-of-way (typically on-street in a former parking space or on curbs). Commonly, stations are placed on public rights-of-way either through a municipal request for proposal (RFP) process granting use of the land in cases of public agency program operation, sponsorship, or operator request through informal agreements, real estate licenses to use, easements, or memoranda of understanding/agreement.

Multimodal Integration

Local and regional governments determine the role of public transit operators in advancing multimodal integration with shared modes. Local and regional governments also often investigate the role of technology, fare integration, and public transit discounts in mitigating obstacles, such as technological barriers, lack of integration within existing transportation systems, skepticism regarding multimodality, and age-dependent travel limitations. Historically, most shared modes, like carsharing and bikesharing, successfully co-located shared services on site or adjacent to public transportation. In October 2014, the San Francisco International Airport (SFO) amended its ground transportation regulations to permit three large ridesourcing service providers to operate on site. SFO authorities again amended their regulations to permit e-hail (pick-up ordered via a computer or mobile device) taxi services to operate at the airport. In March 2015, Orange County California's John Wayne International Airport also amended its policy to permit ridesourcing to pick up and drop off airport passengers. A number of carsharing operators, such as Modo, offer open data on vehicle location, vehicle type, current and future availability, and pricing as part of their API. Public transit agencies can also be instrumental in joint planning processes to integrate shared modes and lease and sub-lease rights-of-way to shared modes for carsharing parking, bikesharing kiosks, for-hire vehicle service loading zones, and other uses.

2.3 Shared Mobility Case Studies

This section provides example case studies representing the general state of practice in the domestic and international mobility landscape, including the services covered, context of the project, and partners. **Appendix A** provides some additional examples of deployments using the shared mobility concept.

At a high level, differences in planning have encouraged different approaches towards solving mobility problems in the U.S. and Europe. The U.S. has seen more of a sprawling suburban development of cities, whereas European cities are

generally much more compact. As a result, cities in Europe generally focus on more evolved MaaS models to make integration of various modes such as bikes and scooters easier and more convenient. International case studies are focused on MaaS through the concept of subscription or pay as you go (PAYG) mobility packages and augmented by the shift towards smart cities and the availability of real-time data for managing transportation networks. Barcelona, Helsinki and Copenhagen are examples of cities leading the way in sustainability, efficiency, and accountability through data-driven smart city initiatives. In the U.S., the trend is projects focused more towards providing service in underserved areas through commuter services and first/last mile solutions. The U.S. trend has also been focused more towards providing MOD through partnerships with TNCs or substituting fixed route services with microtransit.

Agencies are beginning to include autonomous vehicles in their future plans. One such agency working towards this change is the Contra Costa Transportation Authority (CCTA) in the San Francisco Bay Area, which is testing autonomous shuttles to service the Bishop Ranch area.

The case studies are classified into four categories:

1) **Domestic Local Mobility** – Projects in the U.S. where agencies have provided mobility solutions for local commute (e.g., circulators and short-distance on-demand services) by offering new, flexible on-demand services

2) **Domestic Commuter Services** – Projects in the U.S. where agencies have bridged gaps in their services by partnering with TNCs for regional commutes

3) **Domestic Destination-Based Services** – Projects where the origin or destination is fixed and agencies have found solutions to solve the first/last-mile problem for their commuters

4) **International** – Projects from across the globe, showcasing a variety of mobility approaches being taken to offer better services

Table 1 provides a list of projects that have been compiled for this report.

Table 1. Shared Mobility Case Studies

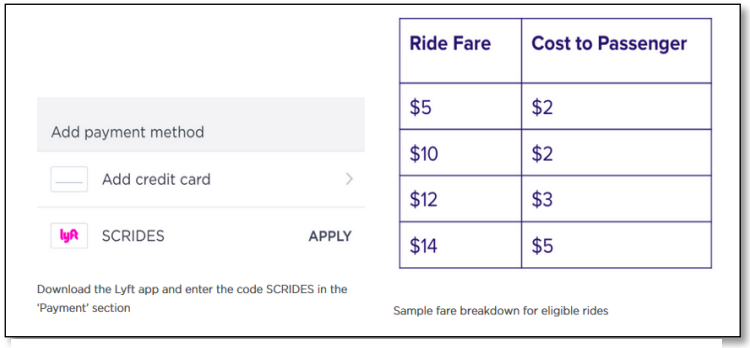
Category	Project	Location	Agency
Domestic Local Mobility	AC Flex	Oakland, California	AC Transit
	Project V Program	Orange County, California	Orange County Transportation Authority
	Direct Connect Services	Pinellas County, Florida	Pinellas Suncoast Transit Authority
	HyperLINK Program	Tampa Bay, Florida	Hillsborough Regional Transit
	NeighborLink Service	Orange, Seminole, and Osceola County, Florida	LYNX
	Early Rider Program	Phoenix, Arizona	Valley Metro/Waymo
Domestic Commuter Services	TNC Partnership	Altamonte Spring, Florida	Municipal Mobility Working Group
Domestic Destination-Based	Rosemont Entertainment Circulator	Suburban Chicago, Illinois	Pace
	Safe Ride Program	Los Angeles, California	University of Southern California
	Autonomous Shuttles	San Ramon (Bishop Ranch), California	CCTA
International	Sentilo Platform	Barcelona, Spain	Barcelona City Council
	City Data Exchange Platform	Copenhagen, Denmark	Municipality of Copenhagen
	Intelligent Transportation System	Singapore	Land Transportation Authority,
	Whim App	Helsinki, Finland	MaaS Global
	VAO	Vienna, Austria	Austria

Oakland, California: AC Flex		***Domestic Local Mobility***
Description: In early 2017, AC Transit, the transit service operator in Alameda and Contra Costa counties, launched a flexible service in the neighborhoods of Newark and Castro Valley (also available in Union City and Fremont)—areas that had low transit demand. Flex is a dynamic reservation-based transit service that uses technology to reduce wait times and provide bus arrival information. All trips must begin and end within the flex service area, which is in proximity of the Line 275, a fixed route that was eliminated. The service area also includes two BART rail stations. As part of the service, AC Transit operates 12-passenger buses equipped with wheelchair access, fareboxes, and Clipper Card (regional smart card fare payment) readers. Implemented as a one-call-one-click concept, the service allows trip booking using a smartphone, tablet, or a computer at any time or through the call center. The trip booking platform is implemented using MobilityDR platform from Demand Trans. Drivers get turn-by-turn directions on Flex vehicles, and riders can subscribe to receive text or email alerts when their vehicles are 10 minutes away. The financial goal for the pilot was to be cost neutral. *AC Flex minibus (Baldassari, 2017)*		
Start Date: 2016	**End Date**: Ongoing	**Funding:** Unknown
Mobility Concept: MOD	**Type of Service:** Microtransit	**Technology Provider:** Demand Trans
Vehicle: 12-passenger vans	**Contractor:** No	
Fare: One-Way trips for adults: $2.35; one-Way trip for youth (5–18) and seniors (65+ years): $1.15		
Target Ridership: Riders along Line 275's discontinued routes		
Mobility Service Zones Defined: Yes		
Risk/Implementation Issues: Upfront capital requirements for buses and technology, however costs were balanced by savings from discontinued fixed route service.		
Marketing: Extensive outreach through a marketing campaign where everyone living within a quarter-mile of the line was sent a flyer and advertising within bus stations.		
Performance: The Flex service completed 23,000 trips in a year and frequency was increased at BART station. 94 percent of the riders surveyed preferred Flex over restoring the fixed route service. On the other hand, only three passengers per hour were serviced—half the number serviced by the fixed route service it replaced. The agency determined that they were able to offer faster service to the riders while staying revenue neutral. AC Transit decided to continue with the service and are planning to analyze their network with an eye to increase their Flex route service area and focusing use of fixed route vehicles on high-demand routes (Flex V. Fixed: An Experiment in On-Demand Transit, 2018).		
Relevance to VA Agencies: Such experiment could be applicable to several small urban and urban agencies in Virginia who may		

be planning to cut back on service or trying to serve underserved areas.

Orange County, California: Project V Program — *Domestic Local Mobility*

Description: Project V is a part of the California Measure M2 initiative, which includes a process for local communities to develop their own transit services that complement the regional transit services. When Orange County Transportation Authority (OCTA) decided to eliminate two of its unproductive routes (191 and 193) due to low ridership in the City of San Clemente, the City and OCTA decided to partner with Lyft to provide on-demand services to riders dependent on those routes. The project is funded by an OCTA grant for a duration of 2 years beginning in 2016. Overall, OCTA pays 90 percent of the operating deficit and the City pays a local match of 10 percent. This contract will allow riders affected by discontinued routes to travel locally or travel to another OCTA route or to the regional MetroRail service (Reimagining Public Transit in San Clemente, 2016).



Pricing scheme (Lyft, 2016)

Start Date: 2016	**End Date**: Ongoing	**Funding**: $900,000 (OCTA Grant)
Mobility Concept: MOD	**Type of Service:** Ridesourcing/TNC Partnership	**Technology Provider:** Lyft
Vehicle: Sedans	**Contractor:** Lyft	

Fare: Passenger pays first $2.00 of the regular Lyft fare; City pays remainder up to a maximum of $11.00 (up to $9.00 subsidy); customer is responsible for any amount above $11.00

Target Ridership: Riders along discontinued routes

Mobility Service Zones Defined: Yes

Risk/Implementation Issues: Ridership data access, less control over quality of service

Marketing: N/A

Performance: The project is still ongoing. The city has sought to increase funding for the program and offer increased credits for riders who use the service regularly.

Relevance to VA Agencies: Such experiment could be applicable to several small urban and urban agencies in Virginia who may be planning to cut back on service or trying to serve underserved areas.

N/A: Information not available at time of publishing this report

Pinellas County, Florida: Direct Connect Services		***Domestic Local Mobility***
Description: In 2016, PSTA launched a unique public-private partnership program to enhance local mobility by partnering with Uber and United Taxi. PSTA was the first agency in the country to subsidize Uber trips. This service is designed to address the county's sprawling population and service gaps that require riders having to walk long distances to get to a bus stop. The initial deployment covered trips to or from certain zones. This was found to be confusing to the customers and the program was expanded and simplified to provide trips to or from 20 Direct Connect stops across the county. PSTA partnered with Uber, Lyft, and United Taxi to offer discount coupons which could be used over respective e-hailing platforms. Involving a local taxi company and wheelchair accessible paratransit vehicles enabled people without smartphone access to use the services by calling to book rides. PSTA identified five routes with low ridership and replaced them with Direct Connect services.		
Start Date: 2016	**End Date**: Ongoing	**Funding**: $500,000 (MOD Sandbox) and $125,000 (Local Government)
Mobility Concept: MOD	**Type of Service:** Ridesourcing/TNC Partnership	**Technology Provider:** Uber, Lyft, and United Taxi
Vehicle: Sedans	**Contractor:** Uber, Lyft, and United Taxi	
Fare: PSTA provides a discount of $5.00 per trip; passengers pay an average of $1.00; wheelchair transport riders receive up to $25.00 discount per trip		
Target Ridership: Riders along discontinued routes		
Mobility Service Zones Defined: Yes		
Risk/Implementation Issues: Access to ridership data and no regulation over TNCs for minimum fare requirements		
Marketing: Brochures, newspapers, interior bus posters, designated service stop signs, and website		
Performance: The agency has seen a consistent increase in ridership with its Direct Connect program growing from 210 trips per month in March 2017 to an average of 5,000 trips per month in October 2018. One of the major lessons learned from this program was that agencies should clarify their data requirements from TNCs in the contract. Currently, Uber shares average trip length, average wait time, and station level data. Another aspect realized was that TNCs could raise minimum fares without notice since PSTA did not have any authority over pricing. At the beginning of the program, minimum fare for an Uber ride was $5.95 but is currently $7.62. NTD reporting is difficult since Uber rides are not considered as shared rides except for UberPOOL.		
Relevance to VA Agencies: Such experiment could be applicable to several small urban and urban agencies in Virginia who may be planning to cut back on service or trying to serve underserved areas where customers do not have first/last mile connections to transit services.		

Tampa Bay, Florida: HyperLINK Program		***Domestic Local Mobility***
Description: Hillsborough Regional Transit (HART) launched the HyperLINK service in November 2016 to provide direct connections to bus stops in Brandon, Temple, Terrace, and University Area neighborhoods and was the country's first "transit-operated rideshare." The service was designed as a shared ride service for first/last mile connections. The service is operated by Transdev, which is paid $10 per trip. Riders can pay by cash or credit cards. HyperLINK is ADA accessible and can be hailed by using the HyperLINK app, which uses GPS much like Uber and Lyft. Riders can also book a ride by calling the HART dispatch. The service lets users book rides to and from bus stops in three designated areas: Brandon, North Tampa, and Carrollwood. Private business donors (led by TECO) are funding the $170,000 2-year leases for four Tesla Model X SUV vehicles. One wheelchair accessible van was used to assist people with disabilities (HART launches HyperLINK program, 2017). HART also planned on using Tesla vehicles equipped with autonomous vehicle technology in the future (initially it will have drivers to ensure safety). HART discontinued the service per recommendation of the Mission Max study because the service was not financially sustainable. *HyperLINK Tesla donated by TECO (Bikewalktampabay.org, 2017)*		
Start Date: 2016	**End Date**: 2018	**Funding**: $1.2 million (Florida Department of Transportation)
Mobility Concept: MOD	**Type of Service:** Microtransit	**Technology Provider:** HART
Vehicle: Sedans, Vans	**Contractor:** TransDev	
Fare: Riders pay $1 to connect to a designated HART stop; riders pay $3 to connect to anywhere on the service zone		
Capital Cost: N/A	**Annual Operating Cost:** N/A	**Revenue**: N/A
Target Ridership: Transit riders in need of first/last mile connections		
Mobility Service Zones Defined: Yes		
Risk/Implementation Issues: High operating costs with low ridership. Operating costs ranging from $200,000 to $800,000. (HART, 2017)		
Marketing: N/A		
Performance: The program saw an increase in ridership that averaged 5,200 trips per month during their 1-year pilot period. The service was ended in July 2018.		
Relevance to VA Agencies: Such an experiment may be applicable to agencies in Northern Virginia who may have first/last mile		

connectivity issues.

N/A: Information not available at time of publishing this report

Orange, Seminole, and Osceola Counties, Florida: NeighborLink Service — *Domestic Local Mobility*

Description: LYNX offers a flex service called NeighborLink (NL) for its riders living in low density areas that are underserved by its local bus system. LYNX currently has defined 13 NL routes and zones. Riders can use an app to book trips to travel anywhere within the zone or to and from a stop on an NL route. Similar to AC Flex, LYNX operates small vehicles branded for NL service.

LYNX has been offering NeighborLink for several years but it required booking rides 2 hours in advance until 2017 when the app was launched. LYNX has partnered with DoubleMap to provide the trip booking and dispatching platform. Also, DoubleMap provides real-time information and alerts to riders. The service is operated by LYNX's paratransit service (ACCESS) contractor, MV Transportation.

NeighborLink minibus (LYNX, 2016)

Start Date: 2014	**End Date**: Ongoing	**Funding**: N/A
Mobility Concept: MOD	**Type of Service:** Microtransit	**Technology Provider:** DoubleMap
Vehicle: Sedans, Vans	**Contractor:** MV Transportation	
Fare: Riders pay $2 for full fare; riders pay $1 for reduced fare		
Capital Cost: N/A	**Annual Operating Cost:** N/A	**Revenue**: N/A
Target Ridership: Low-density area riders		
Mobility Service Zones Defined: Yes		
Risk/Implementation Issues: Initial capital costs associated with technology development ($500,000) and high annual operational costs (estimated as $1.3 million).		
Marketing: N/A		
Performance: NeighborLink service saw a ridership of 97,554 in Fiscal Year (FY) 2018, which has declined from the 3 previous years.		
Relevance to VA Agencies: Such experiment may be applicable to suburban/rural agencies where transit service is limited due to low density.		

N/A: Information not available at time of publishing this report

Phoenix, Arizona: Early Rider Program ***Domestic Local Mobility***

Valley Metro Regional Public Transportation Authority partnered with Alphabet-owned Waymo to shuttle passengers to and from transit stations. The idea is to use autonomous self-driving technology to better connect travelers with the city's existing buses and light rail. The first phase of this partnership, which started in August 2018, provides first/last mile solutions to Valley Metro employees—helping them connect with public transit. The service is used to shuttle 30–40 employees who live in Waymo's east side service area on driverless Chrysler Pacifica's. The second phase will be used to service Valley Metro RideChoice travelers, which cover groups traditionally underserved by public transit. The RideChoice program is used to provide discounted rides to seniors and people with disabilities.

Waymo autonomous shuttle in Arizona (CNET, 2018)

There is another pilot program being run in Phoenix where people can volunteer to use Waymo for commuting, and around 400 people have signed up for the service so far. Waymo is also partnering with Walmart to test using its technology in offering delivery services.

Start Date: 2017	**End Date**: Ongoing	**Funding**: N/A
Mobility Concept: MOD	**Type of Service:** Ridesplitting	**Technology Provider:** Waymo
Vehicle: Sedans/Vans	**Contractor:** N/A	
Fare: Free for initial volunteers during test phase		
Capital Cost: N/A	**Annual Operating Cost:** N/A	**Revenue**: N/A
Target Ridership: Riders in low-demand areas		
Mobility Service Zones Defined: Yes		
Risk/Implementation Issues: High upfront cost associated with development of technology and integration with existing infrastructure; regulations and development of autonomous vehicles will take time; operational costs which may vary from $14,000/vehicle/month to $27,000/vehicle/month (Waddell, 2018).		
Marketing: N/A		

Performance: The service is still in its test phase and services are offered in a small area to volunteers of the program. Currently more than 400 riders use it every day (Hyatt, 2018)
Relevance to VA Agencies: TBD

N/A: Information not available at time of publishing this report

Altamonte Spring, Florida: TNC Partnership		***Domestic Commuter Services***
Description: Municipal Mobility Working Group (MMWG) was formed through an interlocal agreement between Altamonte Springs, Maitland, Longwood, Sanford, and Lake Mary in Florida in order to provide their riders with better service. MMWG has created a public-private partnership with Uber to offer subsidized rides in their jurisdiction. Partners of MMWG had earlier launched programs similar to FlexBus providing flexible service offered at 25+ fixed stations and allowing riders to book via smartphones. However, these projects were not very successful due to lack of definitive agreements among the partners on operations and maintenance. The main purpose of the TNC partnership is to provide feeder service to Sun Rail stations, but riders can travel anywhere within city limits and areas that are part of the MMWG agreement. The first phase of the program involved discounts by cities for rides originating and ending in their jurisdiction. The second phase involved discounts on rides which originate in any other city but end in theirs.		
Start Date: Phase I (2015), Phase II (2017)	**End Date**: July 2018	**Funding**: N/A
Mobility Concept: MOD	**Type of Service:** Ridesourcing/TNC Partnership	**Technology Provider:** Uber
Vehicle: Sedans	**Contractor:** Uber	
Fare: Cities pay 20 percent of the ride ending in their jurisdiction and 25 percent of the cost of rides that begin or end at the SunRail station inside of the city.		
Capital Cost: N/A	**Annual Operating Cost:** Phase I: Five cities paid $63,770 for 1-year period Phase II: Five cities paid $330,000 over a 10-month period	**Revenue**: N/A
Target Ridership: Inter-city commuters		
Mobility Service Zones Defined: Yes		
Risk/Implementation Issues: Coordination and serving needs of different partners		
Marketing: N/A		
Performance: This is a good example of how different jurisdictions can help their citizens commute better and offer better services across a region. The cities plan on continuing with this agreement.		
Relevance to VA Agencies: The model can serve as an example for Northern Virginia transit agencies or perhaps the Hampton Roads jurisdictions where residents travel across boundaries to live, work, and play without regard to jurisdictional lines.		

N/A: Information not available at time of publishing this report

Suburban Chicago, Illinois: Rosemont Entertainment Circulator		*Domestic Destination-Based*
Description: Pace, the agency responsible for providing services in suburban Chicago, has launched a shuttle service between the CTA Blue Line subway station and nearby destinations in the Rosemont Entertainment District, Outlet Mall, and Convention Center. The service is provided through partnership between Pace and the Village of Rosemont. Key landmarks serviced by the stop are Donald E. Stephens Convention Center, Fashion Outlets of Chicago, MP Financial Entertainment District, and Rosemont CTA Station. The service is free and offered as Pace route 811. The purpose of this project is to reduce parking and congestion while providing transit options between local attractions and metro lines. Operations are outsourced to MV Transportation.	*Entertainment Circulator (Rosemont, 2018)*	
Start Date: 2013	**End Date**: Ongoing	**Funding**: N/A
Mobility Concept: MOD	**Type of Service:** Microtransit	**Technology Provider:** Demand Trans
Vehicle: Vans	**Contractor:** MV Transportation	
Fare: Free		
Capital Cost: N/A	**Annual Operating Cost:** N/A	**Revenue**: N/A
Target Ridership: Tourists		
Mobility Service Zones Defined: Yes		
Risk/Implementation Issues: N/A		
Marketing: N/A		
Performance: Two years since the start of service, the Entertainment Circulator had seen a 16.3 percent increase in ridership averaging at 1,250 passengers per day in 2015. In 2018, ridership averaged 1,400 passengers per Saturday, 1,100 passengers per Sunday, and 860 passengers per weekday.		
Relevance to VA Agencies: Such example may be applicable to agencies in urban areas that may be providing destination-based shuttle/circulator services.		

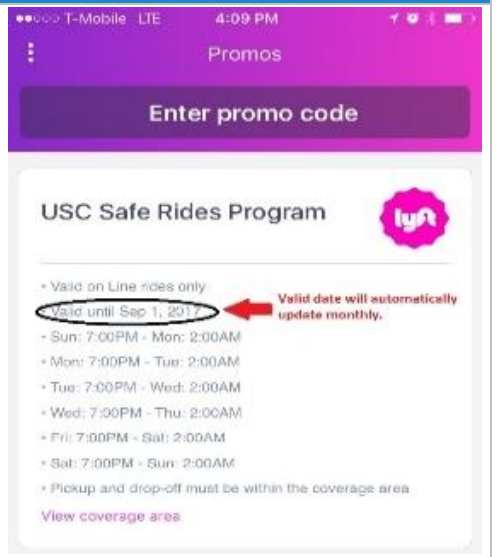
N/A: Information not available at time of publishing this report

Los Angeles, California: Safe Ride Program — *Domestic Destination-Based*

University of Southern California provides a free safe ride program in partnership with Lyft in the University Park neighborhood from 7 PM to 2 AM 7 days a week. The University started with a Campus Cruiser program to help commute on- and off-campus, but the service soon became overcrowded, so the university partnered with Lyft.

Students can board Lyft Line vehicles from designated pick-up and drop-off locations within University Park. Ride credits for unlimited rides are applied to student accounts; however, excessive "Prime Time" fares or tips are not covered by the ride credits.

The service allows student riders to bring a companion for free. This service is designed to supplement the Campus Cruiser service and initially operated as a pilot program from January 7 through May 9, 2018. The partnership continued for the fall 2018 semester.



An automatically-updated promo code for the program (USC, 2018)

Start Date: 2018	**End Date**: Ongoing	**Funding**: N/A
Mobility Concept: MOD	**Type of Service:** Ridesplitting/TNC Partnership	**Technology Provider:** Lyft
Vehicle: Sedans	**Contractor:** Lyft	
Fare: Free		
Capital Cost: N/A	**Annual Operating Cost:** N/A	**Revenue**: N/A
Target Ridership: Students		
Mobility Service Zones Defined: Yes		
Risk/Implementation Issues: Ridership data and congestion		
Marketing: N/A		
Performance: Lyft service has shown ridership of up to 30,000 rides per week. However, the Department of Public Safety has reported an increase in the number of traffic collisions due to rideshares.		
Relevance to VA Agencies: Areas with high student populations (for example, Blacksburg, Harrisonburg, and Charlottesville) could use this model to service increasing demand without high upfront capital investments		

San Ramon, California: Autonomous Shuttles ***Domestic Destination-Based***

CCTA, backed by a combination of private companies, public transit, and air quality authorities, has launched a driverless shuttle service. Two 12-seat shuttles, provided by EasyMile, are being tested to offer service in the area. CCTA plans to operate nearly 100 shuttles by 2020.

The majority of funding is provided by owners of Bishop Ranch, a Sunset Development Company. Bishop Ranch is a 585-acre office park that includes 550 tenants and an employment population of 30,000. Shuttles provide service in the office park area and provide first and last mile connectivity to a nearby BART station. The shuttle is meant to transform first/last mile connections in the area and fill gaps in the current transit system.

EasyMile autonomous shuttle (Bishop Ranch, 2017)

The shuttle is the first driverless shuttle that California Department of Motor Vehicles has granted permission for operations. Bishop Ranch offers an ideal location for autonomous vehicles, where employees need a shuttle to commute from the nearest BART station to the office park. A hub-and-spoke model is planned for these services to facilitate use of mass transit as backbone and the autonomous shuttles as a first/last mile solution.

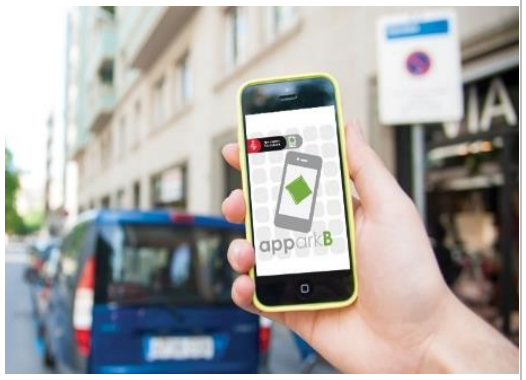
Start Date: 2017	**End Date**: Ongoing	**Funding**: N/A
Mobility Concept: MOD	**Type of Service:** Microtransit	**Technology Provider:** EasyMile
Vehicle: 12 Passenger Shuttle	**Contractor:** N/A	
Fare: Free		
Capital Cost: N/A	**Annual Operating Cost:** N/A	**Revenue**: N/A
Target Ridership: Bishop Ranch office park commuters and other nearby area demand		
Mobility Service Zones Defined: Yes		
Risk/Implementation Issues: Regulations and development of autonomous vehicles will take time. Operational costs which may vary from $27,000/vehicle/month for 1-year contract to $8,000/vehicle/month for a 5-year contract. (Waddell, 2018)		
Marketing: N/A		
Performance: The service is still in its test phase and is only functional along one route		
Relevance to VA Agencies: This model may be applicable in a downtown circulator environment.		

N/A: Information not available at time of publishing this report

Barcelona, Spain: Sentilo Platform ***International***

Barcelona and surrounding cities have implemented an open-source platform called Sentilo that brings together data from multiple sources and underpins the deployment of smart parking and smart transit services. The City Council has also implemented City OS to connect various city projects and services on a single platform. The inspiration behind Sentilo was to create a cross-platform oriented infrastructure and data management service for sharing information between heterogeneous systems. Sentilo is an open-source platform; third parties can build upon this code without worrying about licensing issues. There are no restrictions on the use of Sentilo even for commercial use by private companies.

Using the data assimilated in Sentilo, Barcelona has also experimented with a new transfer-based service and re-routed their services, reducing their service to 28 lines from 63 lines. A bike sharing system has been started across the city to reduce the number of cars on the road which gathers data from these sensors aggregated over Sentilo and helps riders find available bikes. Most of the bike stations are located close to car parking, parks, and metro stations.



ApparkB, parking app using data from Sentilo (CNET, 2018)

ApparkB is a smart parking application resulting from this data which guides drivers to available parking spaces based on a sensor network and allows drivers to pay for the parking spaces as well (Calzada, 2018). One of the major goals of the city, which is common across Europe, is to reduce car ownership and the increases the availability of real-time data on all possible modes of transport facilitates. (Hill, Gibson, Guidorzi, Amaral, Parlikad, & Jin, 2017).

Start Date: 2014	**End Date**: Ongoing	**Funding**: Barcelona City Council
Mobility Concept: Smart City	**Type of Service:** Mobile Platform (Payments & Planning)	**Technology Provider:** N/A

Risk/Implementation Issues: Data collection from various third-party applications, security, and revenue management

Performance Measurement: Dubai, Reus, Terrassa and 50 other cities are installing Sentilo for monitoring and management. Data gathered on Sentilo is also being seen as a source of revenue that, when shared with third parties, would help them build better services for the citizens. By making investments in common infrastructure and leveraging data, the city can facilitate deployment of the latest technology in minimum time.

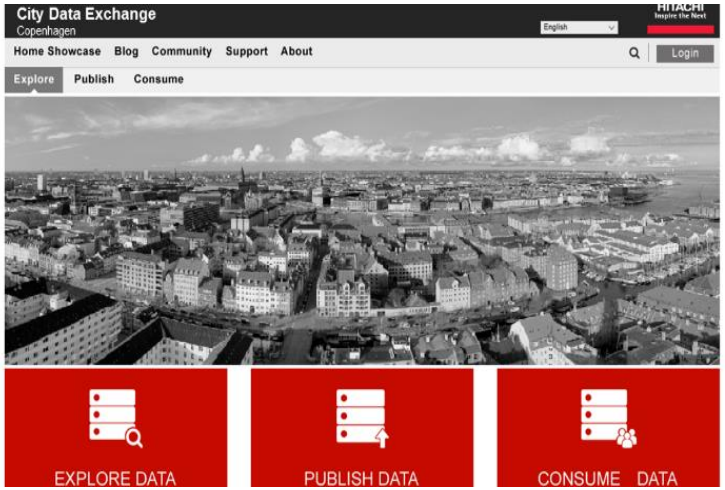
Relevance to VA Agencies: Statewide deployment of a similar platform could assist in planning and decision making

N/A: Information not available at time of publishing this report

Copenhagen, Denmark: City Data Exchange Platform — *International*

In its efforts to achieve its goal of becoming a Carbon Neutral Capital City by 2025, Copenhagen has launched the world's first city data marketplace, The City Data Exchange (CDE). The project is a collaborative project between Municipality of Copenhagen and Capital Region of Denmark. Hitachi is the technology consultant and has also invested in the platform. It is the first city to attempt monetizing its and others' data through a city data market.

CDE is a self-sustaining platform which generates revenue by giving companies access to data. One of the most in demand datasets covers people's movement patterns, which can be gathered through cell phone tracking, wireless connection counting, camera image counting, traffic sensors, ticket purchases, etc. For example, transportation sector companies can request information on the number of people travelling between places, to plan their services and understand their ridership characteristics.



City Data Exchange (Copenhagen Solutions Lab, 2018)

Start Date: 2016	**End Date**: Ongoing	**Funding**: Municipality of Copenhagen
Mobility Concept: Smart City	**Type of Service:** Mobile Platform (Analytics)	**Technology Provider:** Hitachi

Risk/Implementation Issues: Immature market, fragmented data landscape, security

Performance: Within its first year, CDE gathered data on 140 datasets which included priced data from private sector organizations like GoBike, car sharing companies, and data on bus and train riders. The city combines raw people movement patterns and the additional information it gathers from other datasets to deliver to paying customers. By doing so, the city not only has firsthand access to data but also on the emerging technology being built using this data. Data from this platform is being used by city planners and has already helped the city create 400 kilometers of cycle paths including 26 "Cycle Super Highways". The city also uses dynamic bicycle signage providing cyclists real-time information on traffic along with smart street lights just for cyclists.

Relevance to VA Agencies: This could be implemented regionally `or statewide, giving authorities' access to valuable data to assist in planning and decision making.

N/A: Information not available at time of publishing this report

Singapore: Intelligent Transport System *International*

Singapore has limited land for development, hence the need to manage existing resources efficiently. A complex Intelligent Transport System was developed that, apart from managing the transport system, can manage free public transportation in pre-morning hours, electronic road pricing, taxi GPS systems, vehicle quota systems, and congestion charges. Taxi GPS systems provide the city with critical real-time data which helps in congestion management and dynamic parking prices. The city has installed Electronic Regulatory Signs which help the controller direct traffic and reduce congestion in real-time.

Garmin fitness tracker being used for payments (CNET, 2017)

By using data analytics, the government looks to manage its bus fleets, reduce crowdedness and improve punctuality of public transport. All data from the sensor networks is channeled to the ITS control center, which gives the authorities a glimpse of the trends in movements and helps in better decision making.

The city has also deployed sensors to monitor traffic, air quality, and public safety. The city uses sensors to monitor the number of people waiting at bus stops. The data is collected by Future City Lab to assess the impacts of updating the network in terms of congestion, traffic patterns, and customer behavior. EZ-Link, a card payment issuer working with government authorities, has made it possible to pay for trips using fitness and health trackers like Fitbit and Garmin. Initiatives like Green Man+, which addresses needs of elderly pedestrians and people with disabilities who may require additional time to cross the road, are deployed faster when infrastructure is available.

Start Date: 2014	**End Date**: Ongoing	**Funding**: Land Transport Authority (Singapore)
Mobility Concept: Smart City integration	**Type of Service:** Payments and Traffic Management	**Technology Provider:** Fitbit, Garmin
Risk/Implementation Issues: Easier to deploy a central system for small geographic area		
Performance: Singapore has become one of the least congested major cities of the world and has stayed competitive even though its population has doubled in 2 decades. Road fatalities have dropped from 210 in 2000 to 122 in 2017.		
Relevance to VA Agencies: Centralized ITS would give agencies access to data, enabling better management and decision making.		

N/A: Information not available at time of publishing this report

Helsinki, Finland: Whim App ***International***

Helsinki aims to reduce private car ownership and increase public-private transportation systems. The Ministry of Transport and Communication in Finland has had a MaaS component in its legislation since 2011. To achieve the goal of providing MaaS, the startup MaaS Global created an app called Whim—a single platform solution for mobility across the city. Prior to Whim being launched, the government simplified a lot of legislation like distinguishing between taxis and ride-hailing services. The subscription-based integrated mobility app offers users access to a variety of transportation modes. The app learns users' preferences and syncs with their calendars to intelligently suggest ways to commute. Booking and payments systems have generally been separate for each leg of the journey; Whim aims to change this by removing the guesswork and combining options in the most efficient and cost-effective way (Aapaoja, Eckhardt, Nykänen, & Sochor, 2017).

	Whim Urban 30 €62 / 30 days	Whim Unlimited €499 / month	Whim to Go Pay as you go
Public transport	HSL 30-day ticket	Unlimited HSL single tickets	Pay as you go
City bike	Unlimited	Unlimited	Not included
Taxi (5km)	€10	Unlimited	Pay as you go
Rental car	€49/day	Unlimited	Pay as you go
Car share	Coming soon	Unlimited	Coming soon

Start Date: 2016	**End Date**: Ongoing	**Funding**: N/A
Mobility Concept: MaaS	**Type of Service:** Mobile Platform (Planning and Payments)	**Technology Provider:** MaaS Global

Risk/Implementation Issues: Difficult to get all stakeholders on board for a larger application area; regulation and access to data, revenue management

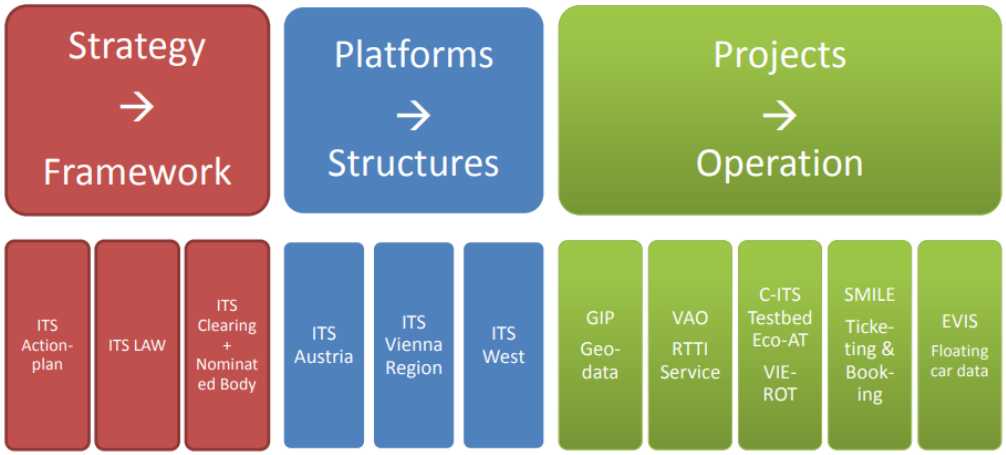
Performance: Whim is by far the most advanced MaaS platform tested on a large urban stage. The app has shown that planning and payments of different modes of transport operated by different entities can be offered on one single platform. The government introduced a new law which requires both private and public service providers to share data through an open API to help new services. Earlier in 2018, Whim was launched in Birmingham (United Kingdom) and will soon be rolled out in Antwerp (Belgium).

Relevance to VA Agencies: TBD

N/A: Information not available at time of publishing this report

Vienna, Austria: VAO ***International***

The Austrian government identified the following barriers to mobility: variety of services, mono-modal platforms, various databases, and a high diversity with limited coverage of services. VAO was a solution to overcome those barriers. VAO traffic information is used in journey planners by a variety of platforms; among them are AnachB, the motorway operator ASFINAG, and nine other institutions. VAO is offered as a stand-alone traffic information platform, but also serves as the basis for the respective traffic information provided by its partners. The journey planner provides: (i) intermodal Austria-wide door-to-door routing; (ii) comparison of travel times and environmental aspects of the trip; (iii) public transport timetables; (iv) real-time and forecast of traffic situations; (v) information on park-and-ride and kiss-and-ride facilities; (vi) map information and alerts related to roadwork, detours, and traffic problems. The platform's advice is neutral—there is no preference for individual transport companies (Menzel, Böhm, & Zwick, 2014).



Start Date: 2012	**End Date**: Ongoing	**Funding**: $5,300,000 (Multiple Sources)
Mobility Concept: ITS and MaaS	**Type of Service:** Data platform	**Technology Provider:** Weiner Linien (Public Transport Provider)

Risk/Implementation Issues: Data collection from various third-party applications, security, revenue management

Performance: The platform is serving as a central hub for all data exchanges. This has led to development of successful MaaS deployments like WeinnMobil (MaaS platform). It helps in forming synergies in development, purchase and licensing with various partners.

Relevance to VA Agencies: TBD

N/A: Information not available at time of publishing this report

2.4 Transit Technology State of the Practice

Advancements in technology are playing a key role in the changing mobility landscape. Transit agencies and mobility providers are leveraging technology to offer convenience to the users in the areas of trip booking, payment, and planning; to improve operations and maintenance efficiency and service reliability; and to provide a safer and more convenient experience for the users.

Table 2 lists the key transit technologies that are being used across the industry in various applications. The table includes a review of the state of practice for each technological solution:

- **Vehicle-based Technologies** – Refer to hardware and software installed on vehicles that support vehicle tracking, operations management, and customer information
- **Technology Systems** – Refer to central hardware and software that support vehicle-based and other technologies
- **Customer Technologies** – Refer to hardware and software that are used to disseminate relevant and real-time information to customers

Based on review of the state of the industry, the level of deployment of technologies is reported in **Table 2** as follows:

- **Low** – Approximately less than 50 percent of agencies use the technology
- **Medium** – Approximately 50 to 75 percent of agencies use the technology
- **High** – Approximately more than 75 percent of agencies use the technology

Table 2. Deployment Status of Transit Technologies

Type	Technology	Description	Deployment Status		
			Rural	Small Urban/ College	Urban
Vehicle - Based Technologies	**Wireless Communications** *Voice*	Two-way radio or other wireless services used for voice communications	High	High	High
	Wireless Communications *Data*	Land mobile radio (LMR)-based or cellular-based data services used for vehicle to central communications	Low	Medium	High
	Digital Signage *Interior*	Visual display of automated next stop announcement texts	Medium	Medium	High
	Digital Signage *Exterior*	Automated or manual display of vehicle destinations and other information	Medium	High	High
	Automated Announcements	Automated announcements of upcoming stops and major intersections per ADA guidelines	Medium	Medium	High
	Computer-Aid Dispatch/Automated Vehicle Location (CAD/AVL) *Vehicle Tracking*	Tools used to track vehicle positions and other relevant operational information	Medium	Medium	High
	CAD/AVL *Driver Interface*	Electronic terminals used by drivers for viewing their work for the day and communicating status of work with control centers	Low	Medium	High
	CAD/AVL *Route/Schedule Adherence*	Automated reporting on vehicles' adherence to predefined route pattern and schedule	Low	Medium	High
	Automatic Passenger Counting	Technologies used on the vehicles to automatically track boarding and alighting of passengers	Low	Medium	Medium

Type	Technology	Description	Deployment Status		
			Rural	Small Urban/ College	Urban
	Fare Collection *Cash and Magnetic Tickets*	Fareboxes that provide the ability to collect payment through cash or swipe of magnetic tickets	High	High	High
Vehicle – Based Technologies	**Fare Collection** *Smartcards/Mobile Payments*	On-board and central technologies that enable fare payment by smartcards and mobile devices	Low	Medium	Medium
	Fare Collection *Account-Based Payment*	Use of central accounts to store customer fare products and does not require customers to carry any specific type of fare media	Low	Low	Medium
	Security *Digital Video Recording*	On-board equipment used to record and store digital video clips on-board vehicles through analog or IP cameras	Low	Medium	High
	Security *Wireless Download/Streaming*	Technology that allows agencies to wirelessly download flagged videos and, in some cases, allows streaming of videos	Low	Low	Medium
	Electronic Maintenance Support *Vehicle Component Monitoring*	Allows agencies to automatically receive and report on fault codes as reported by vehicle components (e.g., multiplex, powertrain, engine, transmission, ABS, and HVAC)	Low	Low	Medium
	Electronic Maintenance Support *Vehicle Inspection/Status Checks*	Tools that help drivers and maintenance staff with walk-around inspections and reporting	Low	Low	Medium

Type	Technology	Description	Deployment Status		
			Rural	Small Urban/College	Urban

Type	Technology	Description	Deployment Status		
			Rural	Small Urban/College	Urban
Technology Systems	**Planning and Scheduling**	Technologies that allow agencies to automatically generate timetables, blocks, runs, and rosters	Medium	High	High
	Computer-Aided Dispatch	Central tools that allow dispatch staff to monitor operational performance of vehicles and drivers and allows them to communicate and initiate timely actions	Medium	High	High
	Maintenance Support Systems	Central systems that allow agency staff to manage parts inventory, identify defects, create/manage work orders, and perform other maintenance functions	Low	Medium	High
	Yard Bus Tracking	Technologies that allow agency staff to automatically locate vehicles and determine their readiness to be dispatched in service when parked in the garage	Low	Low	Medium
	Open Interfaces and Data Exchanges	APIs or interface control documents that reduce the risk of agencies being stuck with proprietary systems	Low	Low	Medium
	Data Analytics/Performance Management/Dashboards	Centralized one-stop-shop reporting tools	Low	Medium	Medium

Type	Technology	Description	Deployment Status		
			Rural	Small Urban/College	Urban
Customer Technology	**Multi-Modal Payment via App**	An application providing customers the ability to pay for different modes that are operated by different agencies by using their mobile devices	Low	Low	Low
	Multi-Modal Trip Planning, Booking, and Coordination App	A single application providing customers the ability to discover, book, and stay informed about their trips involving different modes operated by different agencies by using their mobile devices	Low	Low	Low
	Customer Information and Communications Systems	Applications providing customers real-time or static information relevant to their trips throughout their trip chain	Medium	Medium	High
	On-Board Wi-Fi	Technologies providing customers the ability to access wireless internet while traveling on the bus	Low	Low	Low

2.5 Conclusions

Transit agencies in the U.S. have been partnering with ridesourcing providers (e.g., TNCs), private microtransit companies, and real-time routing and dispatching software providers (e.g., Via, TransLoc, DemandTrans, and DoubleMap) for more than 2 years, especially since the launch of the MOD Sandbox initiative. However, transit agencies are still assessing how to best position themselves in the shifting mobility market. Over this period, agencies have experimented with replacing existing services, complementing current services, and adding new services. Given that most of the operating cost in the transit industry is attributed to direct driver employment and vehicle ownership, agencies have experimented with a variety of models where they (1) operate a service on their own; (2) use a contractor to run their services; or (3) partner with TNC or taxis and subsidize trip cost. While shared mobility modes continue to evolve and reshape the mobility paradigm, some trends continue to be consistent and provide a reasonable outlook for the future of mobility:

- **Focus on customer experience –** Transit agencies have always tried to balance operational management and customer service, but availability of better technologies and real-time data in recent years have prompted agencies to think "customer first." Customer mobility needs vary by geography, socio-economic conditions, and trip purpose, among other things. Through MOD and MaaS, agencies have started to adopt mobility concepts that try to deliver an enhanced mobility experience using mobile devices throughout the entire travel chain.
- **Continued mobility disruption from TNCs and other shared mobility providers –** The private sector continues to be part of the mobility disruption through TNCs and other shared use modes (e.g., carsharing and bikesharing). Choice riders are often relying on privately operated modes for micromobilty needs (trip length less than 5 miles). Also, TNCs are evolving from ridesourcing platforms to mobility platforms as they increase their services in order to include different modes land start to offer transit options and ticketing through their platform. Such companies are trying to become a one-stop solution for all mobility needs.
- **Public transit and integration with shared mobility services –** Until recently, transit agencies and shared mobility options have operated as competing modes, but some agencies have seen their role being elevated to that of a mobility manager and offering public transit services to customers alongside other mobility options. This trend has been evolving since the beginning of the MOD Sandbox initiative. Recent declines in ridership and increases in operating costs have prompted agencies to reduce services and use innovative mobility strategies such as first/last mile solutions and microtransit to continue to serve their customer base. Overall, agencies have been adopting new mobility trends as follows:
  - Implementation of first/last mile strategies in conjunction with rail and dense bus networks, primarily in urban centers
  - Replacing unproductive routes and route segments with microtransit or other on-demand ridesharing services that can complement the existing agency services

- Launch of new on-demand services to serve real-time on-demand mobility needs using emerging technology platforms, often to serve local mobility needs (e.g., shuttles and circulators)
- Partnering with the private sector (e.g., TNCs) to fill mobility gaps in rural and low-density areas
- Development and launch of integrated mobility concepts such as MOD and MaaS to provide compelling, convenient, and cost-effective travel options to customers through their entire travel chain, often involving multiple modes and operators

- **Regulation and data sharing –** Shared mobility modes currently do not fully fit within the realm of modes and trips per statuary definition of the FTA. Certain states, such as California, have taken the lead in defining rules and regulations in the context of emerging modes, but strict regulations applicable to public transit and taxis still do not apply to these modes. This has also created issues for some agencies from their unionized employees when developing public-private partnership programs. Data sharing is another concern since private operators do not share their detailed data for various reasons. Even the APIs available for third-party integration provide limited capabilities and often require the traveler to launch an app from the specific service provider instead of providing an integrated multimodal trip planning and payment experience to customers within a common MOD/MaaS app.

Currently, there is a push by companies and cities across the globe to develop unified technology platforms that would service all mobility requirements of citizens. However, this vision has only been successful in densely populated urban areas of some European cities. Developments outside the U.S. are majorly driven by a motivation to reduce single occupancy vehicle (SOV) ownership and usage. With minimum investments required to build platforms, the cities are encouraging data aggregation, which would then help in better decision making and possibly a source of revenue, as seen in the Copenhagen case study.

In general, the U.S. is currently seeing an increase in number of mobility options and their availability. App-based technology platforms have enhanced their availability and, in some cases, have changed car-ownership trends; however, these platforms have had little positive impact on the congestion on roads (see "TNCs and Congestion" report from San Francisco County Transportation Authority). Mass transit has the potential to reduce congestion while also offering inexpensive accessible and equitable service. While agencies cannot control how TNCs operate due to lack of regulations, they could control certain elements by partnering with them and ensure they are moving towards a collaborative long-term solution. Transit agencies and local/state regulatory bodies should facilitate data sharing policies and other agreements to gain access to data and better understand ridership trends in their jurisdiction. This would assist cities in better adapting to changing mobility trends for better planning of infrastructure.

3. VIRGINIA STATE OF PLAY

3.1 State of Play Summary

This section summarizes the current state of play of integrated shared mobility and transit technology in Virginia. The following major findings are based on stakeholder engagement with transit agencies and organizations across the Commonwealth:

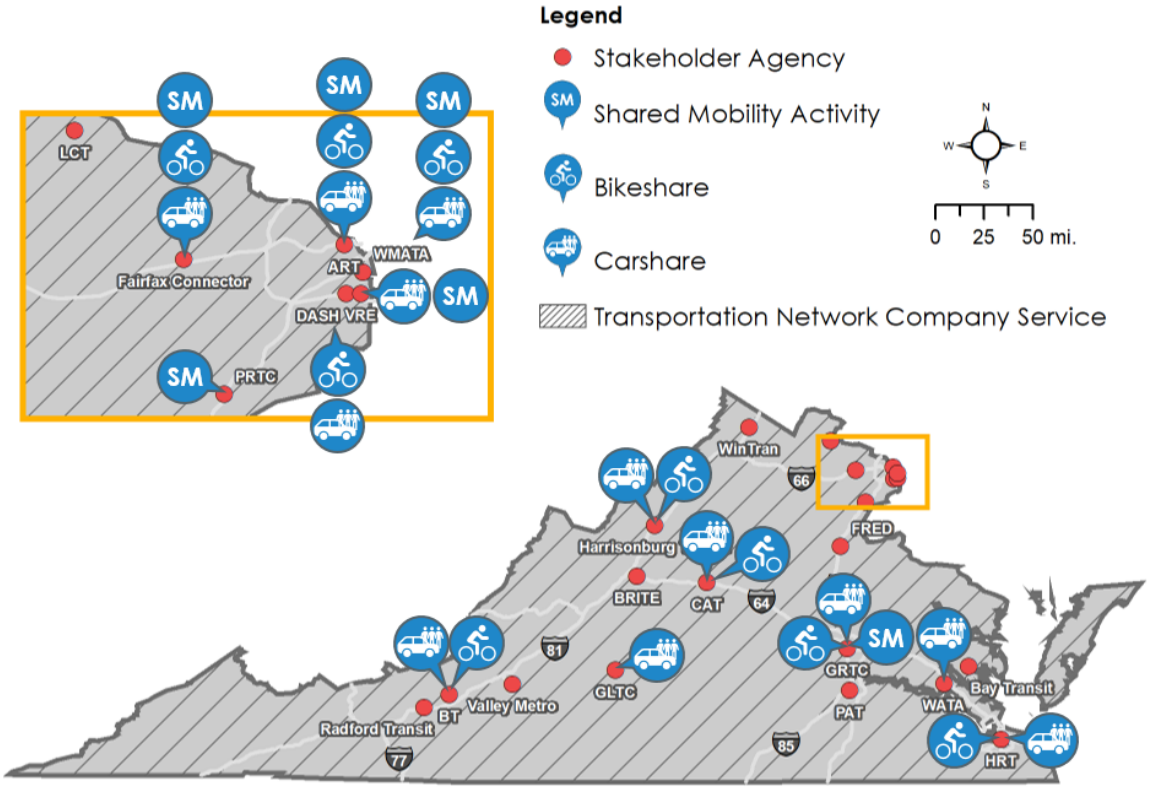
- Transportation network company (TNC) services, bikeshare, and carshare availability is growing. Scooter sharing is also growing in the Washington, D.C., metropolitan area and has recently begun or tried in a few other cities around the state. Multimodal and TNC services are here to stay.
- Traditional demand response or paratransit service is viewed as the extent of shared mobility services in most Virginia communities
- Several transit agencies are beginning to explore alternative transit services or partnerships
- There is clear perception of a problem with ridership trends and the effectiveness of traditional transit services in certain areas
- Shared mobility services are seen more as an opportunity rather than a threat to public transit service in Virginia
- There is a mix of agency interest, readiness, and executive support for partnering with shared mobility providers
- There is a desire for DRPT to provide guidance and support. Technical assistance and grant funding for pilot projects are areas of interest.
- There is a collective view that transit operations and business will change in the future. Transit will become more technology dependent.
- Agencies face challenges with processing, analyzing, and using data from existing technology deployments
- There is a large amount of transit technology investment needed for planned deployments in the next 6 years—both new deployments and lifecycle replacements of existing systems

TRADITIONAL DEMAND RESPONSE OR PARATRANSIT SERVICE IS VIEWED AS THE EXTENT OF SHARED MOBILITY SERVICES IN MOST VIRGINIA COMMUNITIES, BUT SEVERAL TRANSIT AGENCIES ARE BEGINNING TO EXPLORE ALTERNATIVE TRANSIT SERVICES OR PARTNERSHIPS.

The next several sections detail these findings. **Section 3.2** provides examples of existing shared mobility services in Virginia as well as active work with shared mobility partnerships. **Section 3.3** provides more detail from survey results and direct feedback received from stakeholder agencies. **Section 3.4** provides an update on planned ITS and technology deployments for each agency. **Section 3.5** specifically details how agencies are utilizing data from their technology deployments, including use of business intelligence solutions, to better understand their ridership and markets.

3.2 Active Work in Shared Mobility

Shared mobility exists in varying forms in communities throughout Virginia. Shared mobility services and activity in communities served by the stakeholder transit agencies are summarized in **Figure 9**. Transportation network companies have service areas covering the entire Commonwealth; actual availability of service may vary based on the supply and availability of drivers. TNCs started in the Washington, D.C., area in 2012 and began spreading to many other cities in Virginia in 2014. Bikesharing and carsharing services exist in many of the larger metropolitan areas and college towns. Scooter sharing is also growing in the Washington, D.C., metropolitan area and was recently implemented in Charlottesville. Discussions are ongoing with regard to regulation of scooters in Richmond and Norfolk.



Note: Shared mobility services as of September 2018; TNC service availability varies based on supply of drivers.

Figure 9. Shared Mobility Activity in Virginia

Shared mobility integrations or partnerships with transit are much less prevalent, but activity is emerging. Traditional demand response or paratransit service is viewed as the extent of shared mobility services in most communities in Virginia, but several transit agencies are beginning to look more closely at shared mobility

and explore alternative transit services or partnerships. Past and ongoing studies and partnerships are described in the following sections.

Greater Richmond Transit Company (GRTC)

GRTC has established partnerships with two reservations companies UZURV and Roundtrip in 2017 for its paratransit GRTC CARE Program. UZURV and Roundtrip are on-demand/reservation companies that coordinate with private vehicle operators (Uber and Lyft) to serve same-day, direct, non-stop trips. Customers can also reserve trips in advance. Customer eligibility is determined through application and customers are provided an identification card. The customer may call or go online to request a ride. Credit or debit card payment is required and payment is subsidized up to $15 by GRTC while base customer fare is $6 per trip. Trips longer than 7 miles have additional costs to the customer. Customers can also request specific drivers based on their previous experiences with the service.

During the pilot, trips are offered Monday through Friday from 7 AM to 6 PM and on Saturdays from 9 AM to 5 PM. When making a reservation, the customer receives a description of their assigned driver, vehicle, and the type of TNC picking them up. Customers may also request specific amenities or special accommodations, such as low-entry vehicles or trunk space for personal items. Customers requiring mobility device space or special assistance are accommodated to Americans with Disability Act (ADA) guidelines (Greater Richmond Transit Company, 2018).

UZURV drivers must be actively affiliated or partnered with a TNC like Uber or Lyft and, therefore, must meet the requirements of those platforms and the communities they serve (vehicle requirements and inspection, background check, insurance, etc.). Roundtrip partners with Lyft to serve trip requests and partners with other credentialed transportation providers for trips requiring advanced services like wheelchair assistance.

Potomac and Rappahannock Transportation Commission (PRTC)

PRTC has several initiatives in shared mobility. In 2018, it completed a Mobility On-Demand Healthcare Access Feasibility Study that investigated the use of flexible transportation services for trips to and from non-emergency medical appointments. This study researched the current state of practice for serving healthcare trips and evaluated several alternatives for PRTC to implement. The preferred alternative was establishing a partnership between PRTC and a contracted reservation company, similar to a program in use by GRTC, to assign rides to various service providers based on the needs of the user. The partnership and platform is expected to be implemented in 2019. This is viewed as a stepping stone to growing a comprehensive system of mobility for PRTC.

PRTC has also received funding from the I-66 Commuter Choice Program in fiscal year 2018 to implement on-demand shuttles and flexible vanpool services. The free on-demand shuttles will connect neighborhoods with park-and-ride lots and will utilize a software interface to respond to commuter requests with dynamic, real-time routing. The flexible vanpool program will include a smartphone and desktop application to assist with rostering and fare payment.

Arlington County and Metropolitan Washington Council of Governments (MWCOG)

Arlington County is partnering with MWCOG to look at flex service as a concept for serving lower density neighborhoods where traditional fixed-route services are not efficient. Arlington County's transit development plan has identified targeted flex service areas by 2026. A flex transit service would connect residents to the closest transit hub with a frequent fixed-route service. The project will propose parameters for establishing the flex service areas, identify a fare structure, and recommend standards of success. The project is anticipated to be completed in 2019.

Fairfax County

Like Arlington County, Fairfax County is undertaking a transportation study to investigate flexible transit service in various areas of the county, which are identified in its transit development plan. The study will document technology and alternative mobility services and their potential effect on current and future bus operations. If deemed feasible, the study will develop recommendations for a pilot project or partnership to implement new forms of transit service to support existing fixed-route bus service within Fairfax County. The study is anticipated to be completed in 2019.

Virginia Railway Express (VRE)

VRE launched its mobile application, VRE Mobile, in 2015 allowing customers to buy and use tickets and passes with their smartphones. VRE continues to make enhancements to the app and plans to include links to shared mobility services (e.g., Lyft, Car2Go, Zipcar, and Capital Bikeshare). VRE has also been in discussion with Lyft to make first/last mile connections to stations more organized.

Washington Metropolitan Area Transit Authority (WMATA)

WMATA has explored partnerships with Uber during recent accelerated track work surges (SafeTrack) to allow pick-ups to occur at designated locations when a ride is requested from a Metrorail station. Uber also offered discounted rates for UberPOOL trips to and from Metrorail stations during this time. Uber has sponsored late-night service of Metrorail service on occasion as well.

3.3 Survey Results and Other Feedback

Stakeholder input was solicited on the state of play in Virginia regarding agencies' understanding of shared mobility services, the relationship between transit and shared mobility, and agency use of technology and data to understand ridership trends. This input was gathered through (1) an online survey; (2) webinars to review survey results; and (3) a statewide Transit Technology Roundtable organized by DRPT. The survey was responded to by more than 20 transit and transportation demand management organizations from across Virginia. Two webinars were held to review survey results with respondents and to gather other feedback for the project. Finally, the Virginia transit technology community was engaged on the topic of shared mobility through an in-person roundtable in September 2018. The focus of input gathering was on:

- Interest in and support for shared mobility services

- Role of DRPT
- Shared mobility and the future of transit
- Areas of interest to guide the state of the practice review
- Technology, data, and business intelligence

There was a diversity of responses to most survey questions. This speaks to some of the uncertainty around shared mobility and its integration with public transit. In some cases, there was a trend of smaller or more rural agencies answering differently than larger or more urban agencies. This section provides more detail on the state of play findings and includes charts that show the spread of survey responses and the average response for given questions. A detailed survey summary can be found in **Appendix B**.

There is a perceived problem with ridership trends and the effectiveness of traditional transit services in certain areas.

Transit ridership has trended downwards in recent years in most areas of Virginia. In the survey, the problem is clearly articulated but participants are inconsistent on what is causing changing ridership patterns. Multiple factors are reported from gas prices, teleworking, university enrollment, availability of other transportation services, and disconnects between service model and demand.

Most stakeholders agree that their community has underserved areas that are not well-suited to traditional transit service, as seen in **Figure 10**. Small urban or rural agencies are more likely to strongly agree with this sentiment than dense cities. These issues are commonly reported in low density, low population, or suburban areas.

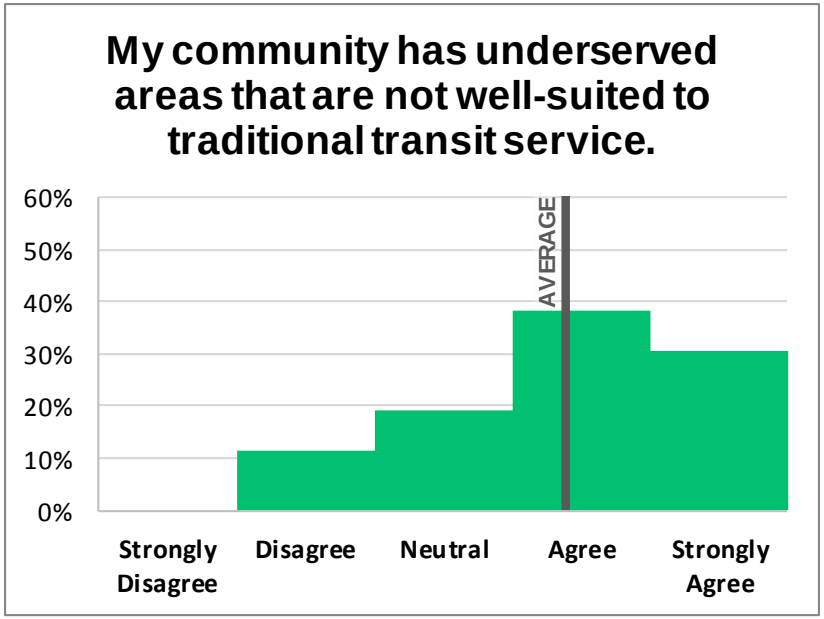


Figure 10. Effectiveness of Traditional Transit Service

Shared mobility services are seen more as an opportunity rather than a threat to public transit service in Virginia.

There is an overwhelming view that shared mobility is an opportunity for public transit in Virginia rather than a threat, as shown in **Figure 11**. Shared mobility has the ability to provide more on-demand, individualized service and expand access to communities. However, large urban transit agencies tend to view it more as a threat, and there is some caution expressed with trading mass transit using buses with single-rider trips.

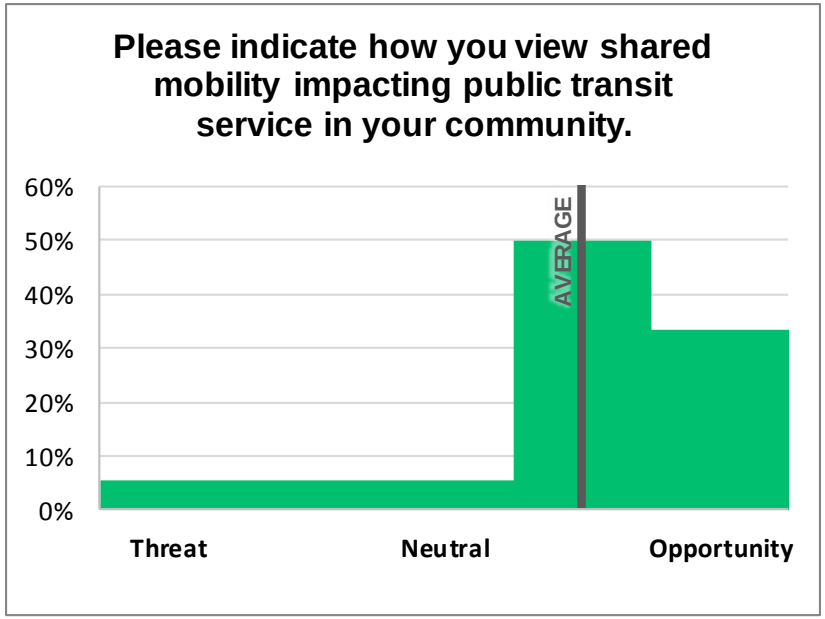


Figure 11. View on Shared Mobility

There is a mix of agency interest, readiness, and executive support for partnering with shared mobility providers.

There is some interest and executive-level support in piloting new service structures, partnering with the private sector on shared mobility (see **Figure 12**), and submitting grant applications for pilots. The response is not negative but not overwhelmingly positive either, indicating that transit agencies are at different levels of readiness. There is also a mix of community and agency readiness for a cultural shift to provide shared rides and shared mobility. Areas of concern include:

- Guaranteeing the level of personalized service and passenger assistance that TNC drivers can provide, which may not match that of the transit agency
- Liability concerns with TNCs—driver background checks, driver training, and vehicle checks
- Compliance with Federal Transit Administration (FTA) regulations and reporting

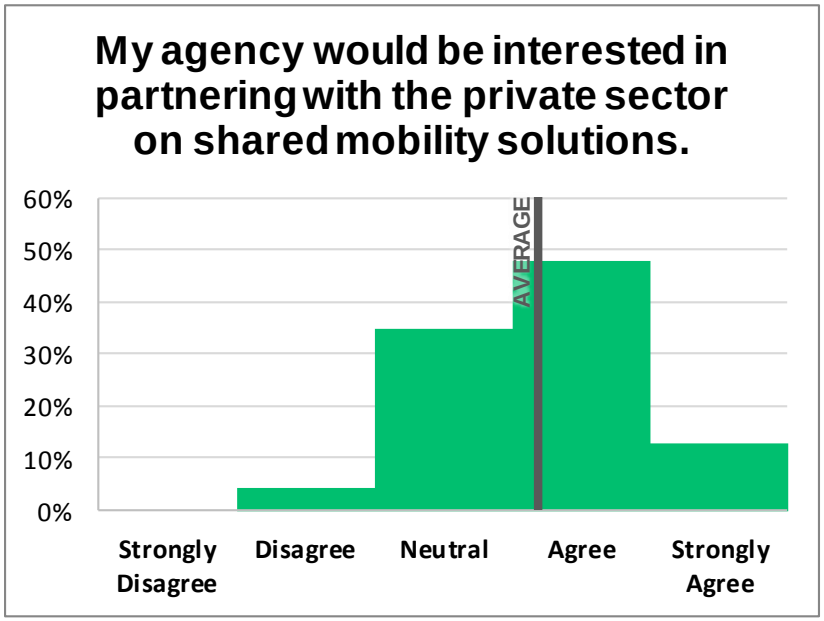


Figure 12. Interest in Partnering with the Private Sector

There is a desire for DRPT to provide guidance and support.

Figure 13 shows the guidance and support desired of DRPT by the stakeholders. The top requests are:

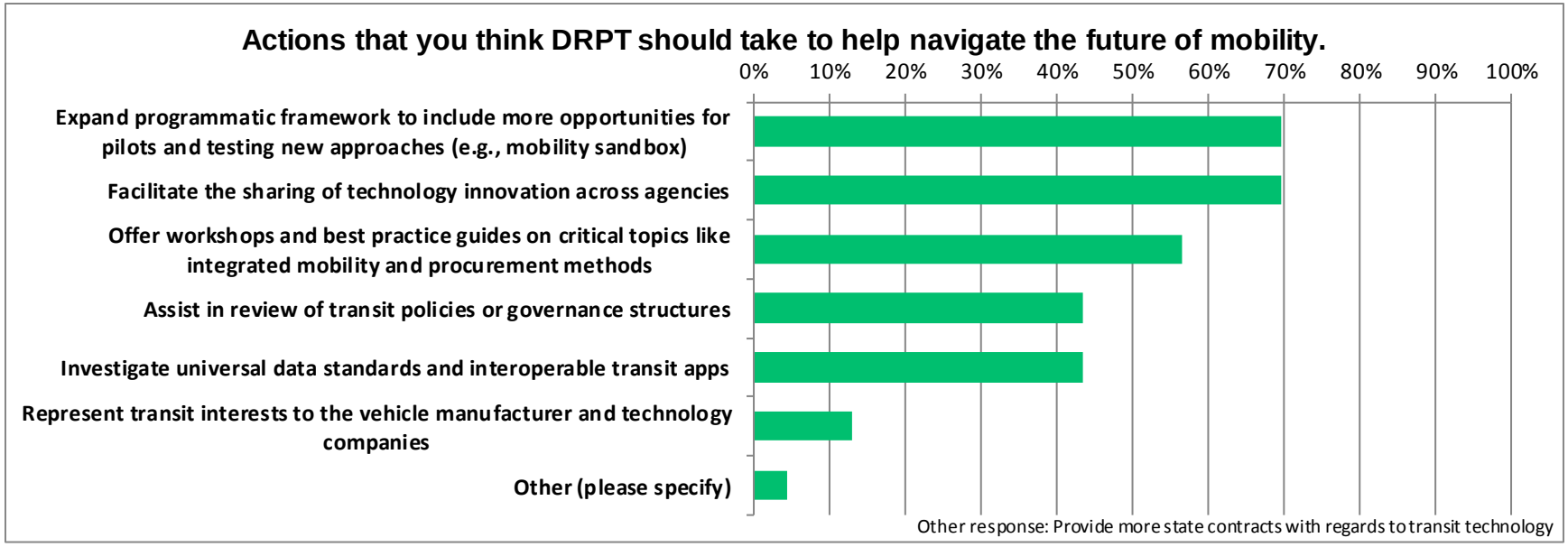


Figure 13. Desired Support from DRPT

- Expand programmatic framework to include more opportunities for pilots and testing new approaches
- Facilitate the sharing of technology innovation across agencies
- Offer workshops and best practice guides on critical topics like integrated mobility and procurement methods

There is a desire to acknowledge these initiatives as research and a learning opportunity; failure is acceptable if there are lessons to be learned. Current frameworks for procurement do not always lend themselves to experimenting and testing, so transit agencies are seeking guidance. Furthermore, pilot projects may require vehicle fleets that the transit agencies are not set up to operate and maintain, therefore capital investment or contracted services will be needed. There is also interest in state contracts for shared mobility partnerships and technology deployments as well as requiring technology deployments funded by DRPT to have contract riders for other transit agencies to also use.

Stakeholders agree that guidance is needed around measuring the success of pilot projects and that the existing performance metrics used by DRPT may not be appropriate. Shared mobility partnerships will likely increase cost per customer, and transit agencies may not have the means to drive this measure down as with traditional service. An accepted definition of a trip is needed in the context of shared mobility; stakeholders want to receive credit for trips served with integrated shared mobility services and not lose out on operating assistance.

There is a collective view that transit will change in the future.

There is general agreement that transit service will change in the future because of shared mobility, as shown in **Figure 14**. Some anticipate that transit will become more on-demand, responsive, integrated with other services, and individualized to customers. There is some agreement that transit vehicles will become smaller to extend service to areas of lower density and ridership. There was strong agreement that transit will become more technologically dependent and investment in technology will be needed (see **Figure 15**). There is less agreement that bus operator responsibilities will change in the future.

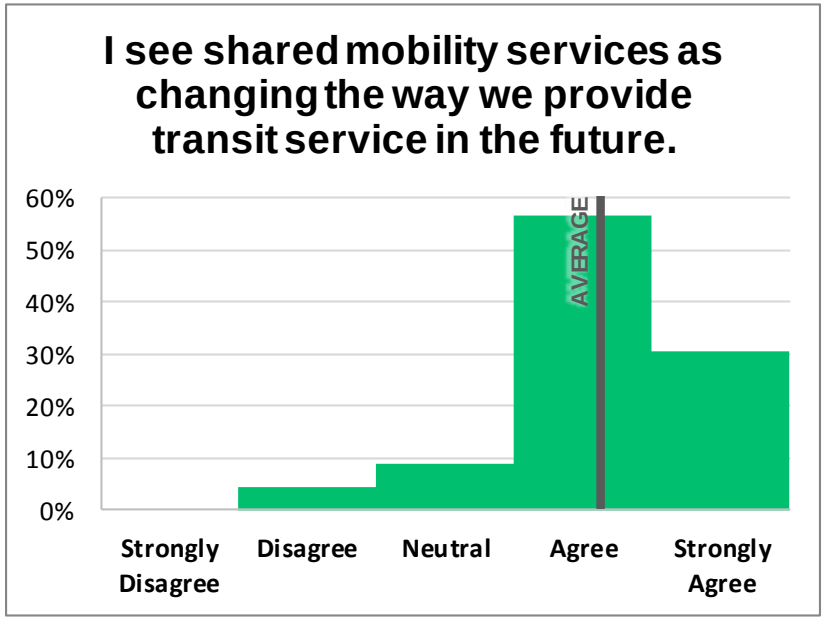


Figure 14. View on Transit Service Change

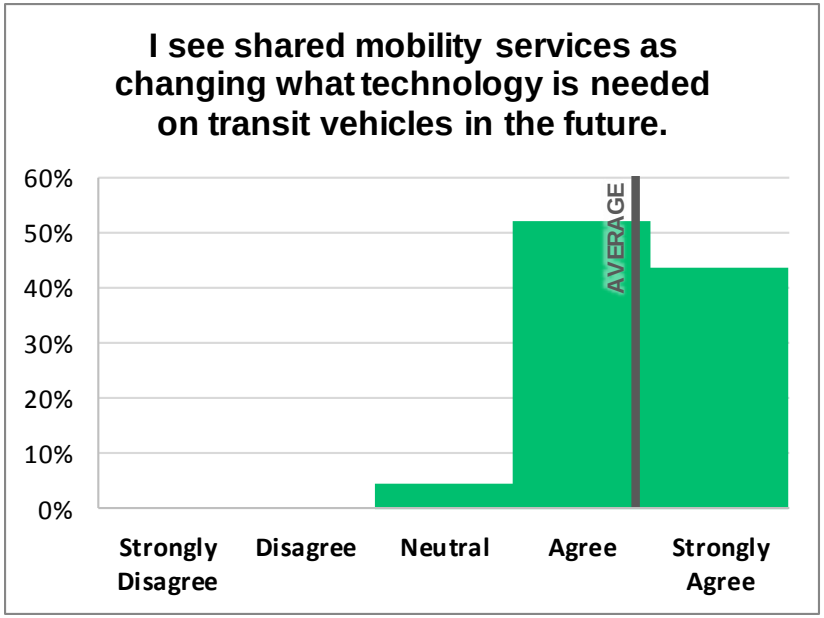


Figure 15. View on Technology Needs

Agencies face challenges with processing, analyzing, and using data from existing technology deployments.

Most shared mobility services and integrations with these services are enabled by technology and data sharing. Therefore, it is important to look at the current capabilities of transit agencies in the area. Transit data is currently being collected and used for performance reporting, but there is inconsistent use of data for regular operations analysis. This is mainly because of a lack of time and staff resources to devote to this. **Section 3.4** shows existing and planned deployments of transit technology in Virginia and **Section 3.5** discusses data and business intelligence in more detail.

3.4 Virginia Technology Plans

A comprehensive view of transit technology deployments was also gathered during the outreach efforts. Each agency's existing, near-term (next 1–2 years), and mid-term (next 2–6 years) deployment plans for ITS are documented in **Figure 16**. A technology acronym guide is provided in **Appendix C**. The matrix is an update to deployment plans documented in Phase 2 of DRPT's Performance Data Collection Standards and Reporting project (2017) and initially developed in DRPT's ITS Strategic Plan (2009).

Overall, there is a large amount of technology investment needed and planned for the next 6 years. This includes both new deployments and lifecycle replacements of existing systems. The majority of fixed-route services have core technologies such as computer-aid dispatch/automated vehicle location (CAD/AVL), automated passenger counters (APC), automated voice annunciation (AVA), and/or cameras. Automated driver assistance systems (ADAS) are emerging with the support of DRPT's demonstration project. This is a pilot program to equip 50 buses in the Commonwealth with MobileEye Shield+ Collision Avoidance System through a statewide cooperative procurement. Transit signal priority (TSP) is on the horizon for several agencies as well. Most demand response services have core technologies such as CAD/AVL, mobile data terminals (MDT), and cameras.

The bulk of planned software enhancements are planned in the areas of real-time traveler information and mobile ticketing. Both are important for potential future integration with shared mobility services.

Planned deployments in wayside equipment are primarily for information displays. There are fewer plans for fare vending machines, which is consistent with the transit industry's trend towards bring-your-own-device, self-service, and use of smartphones for information and fare payment rather than infrastructure-intensive solutions.

There are several reasons why an agency's plans may have changed or were not implemented since DRPT's last update of the matrix in 2017. These include:

- Changing agency priorities
- Staff and executive leadership changeover
- Competing staff responsibilities
- External regional factors (e.g., Northern Virginia fare collection technology is part of WMATA's system)
- Evolving technology offerings by vendors

Transit Technology Deployment Plans (Within Next 6 Years)

Transit Operator	Service Type	On-Board Equipment								Central Systems Equipment											Wayside Equipment			
		CAD/AVL	APC	AVA	TSP	ERF	MDT	Cameras	ADAS	CAD/AVL	GTFS	GTFS-RT	RT Web	RT Mobile	Trip Planner	IVR/SMS	Mobile Ticketing	Scheduling Software	Data Analytics/BI	Maint Mgmt	Yard Mgmt	Info Display	Security Cameras	Fare Vendors	Shared Mobility
Arlington Transit	Fixed Route Bus	■			* ▲		▲	*		■									* ■		▲			*	
Bay Transit	Fixed Route Bus	* ■					* ■											* ■							
Blacksburg Transit	Fixed Route Bus				▲	▲		▲	■			* ■						▲			* ■	▲	▲		■
BRITE	Fixed Route Bus	▲					▲		■	▲			▲	▲	*		▲					▲			
Charlottesville Area Transit	Fixed Route Bus	*	▲	*						*		▲					■		*		▲			▲	▲
City of Winchester	Fixed Route Bus		▲								* ■	* ■			▲								* ■		
DASH	Fixed Route Bus	*			* ■					*							■				▲			*	
Fairfax Connector	Fixed Route Bus							*					*	*			▲				■	* ■			
Fredericksburg Regional Transit	Fixed Route Bus					▲							* ■	* ■	* ■										
Greater Lynchburg Transit Company	Fixed Route Bus	▲	*			* ■			■	▲		▲	▲	▲			■					* ▲	* ■		
Greater Richmond Transit Company	Fixed Route Bus				* ■																			*	
Hampton Roads Transit	Fixed Route Bus	■ ▲		■ ▲		■	■ ▲	■ ▲	■			■	■	■			■	■		■			■		
Harrisonburg Dept. of Public Transportation	Fixed Route Bus	*	*	*	▲		*			*		*	*	*				■							
Loudoun County	Fixed Route Bus	* ■	* ■	* ■	▲	* ■	* ■	■			* ■	* ■	* ■	* ■	* ■	*	▲	* ■				■		■	■
PRTC	Fixed Route Bus											* ■	* ■	* ■			■		* ■						■
Radford Transit	Fixed Route Bus							■														■			
Valley Metro	Fixed Route Bus	* ■	* ■	■	▲		■			■ ▲		* ■	* ■	■	■	* ■	■	■	■			* ■		■	■
Williamsburg Area Transit Authority	Fixed Route Bus	* ▲	* ■	▲			▲			▲	▲		▲	▲		▲	▲	■ ▲							
WMATA	Fixed Route Bus					▲			▲			*										▲		*	
Arlington Transit	Demand Response	* ■					* ■		*	* ■	* ■	* ■	* ■	* ■		* ■			* ■						
Bay Transit	Demand Response																								
Blacksburg Transit	Demand Response								■										* ■		▲				
BRITE	Demand Response	▲					▲		▲	▲			▲	▲								▲			
City of Winchester	Demand Response										* ■	* ■											* ■		
Greater Lynchburg Transit Company	Demand Response						*											*							
Greater Richmond Transit Company	Demand Response					* ■																			
Hampton Roads Transit	Demand Response																						■		
Harrisonburg Dept. of Public Transportation	Demand Response																	■							
Loudoun County	Demand Response	* ■			▲					*					* ■					* ■					
New River Valley Community Services (Radford)	Human Service	▲					▲											▲							
Hampton Roads Transit	Light Rail Transit																								
Hampton Roads Transit	Ferryboat					■																		▲	
Virginia Railway Express	Commuter Rail		■																				■		

LEGEND	
Existing Deployment	
Near-Term Deployment (1-2 years)	■
Mid-Term Deployment (2-6 years)	▲

* Was planned for near-term deployment in Phase 2 of DRPT's Performance Data Collection Standards and Reporting project in 2017.

Figure 16. Transit Technology Deployment Matrix

3.5 Data and Business Intelligence

Existing transit agency capabilities with data collection, management, and business intelligence tools can give an indication of an agency's readiness for integration with shared mobility services, which can be technology and data intensive. They are also critical to data verification and reporting processes for routine reporting to stakeholders including DRPT, FTA, and local funding partners. The stakeholder survey was used to identify the current state of play with data use and business intelligence tools.

Most transit agencies use data reporting tools provided with their CAD/AVL, APC, or fare collection system rather than standalone tools that integrate data from multiple sources. A few of the larger agencies (WMATA, HRT, GRTC, PRTC) have standalone tools or data warehouses that integrate data from multiple sources. This is a capability that is desired by many other transit agencies in the Commonwealth but that is limited by funding and staff resources.

There is a wide use of data to assess and adjust service, but this is not consistently done by all agencies. This includes:

- Establishing key performance indicators (KPIs) to monitor system and route performance
- Reviewing on-time performance, dwell times, and schedule adherence
- Reviewing stop-level ridership to evaluate consolidation of underutilized stops
- Identifying trips that experience bus crowding
- Reviewing ridership trends like viability of routes and stops

4. RECOMMENDATIONS

4.1 Recommendations Summary

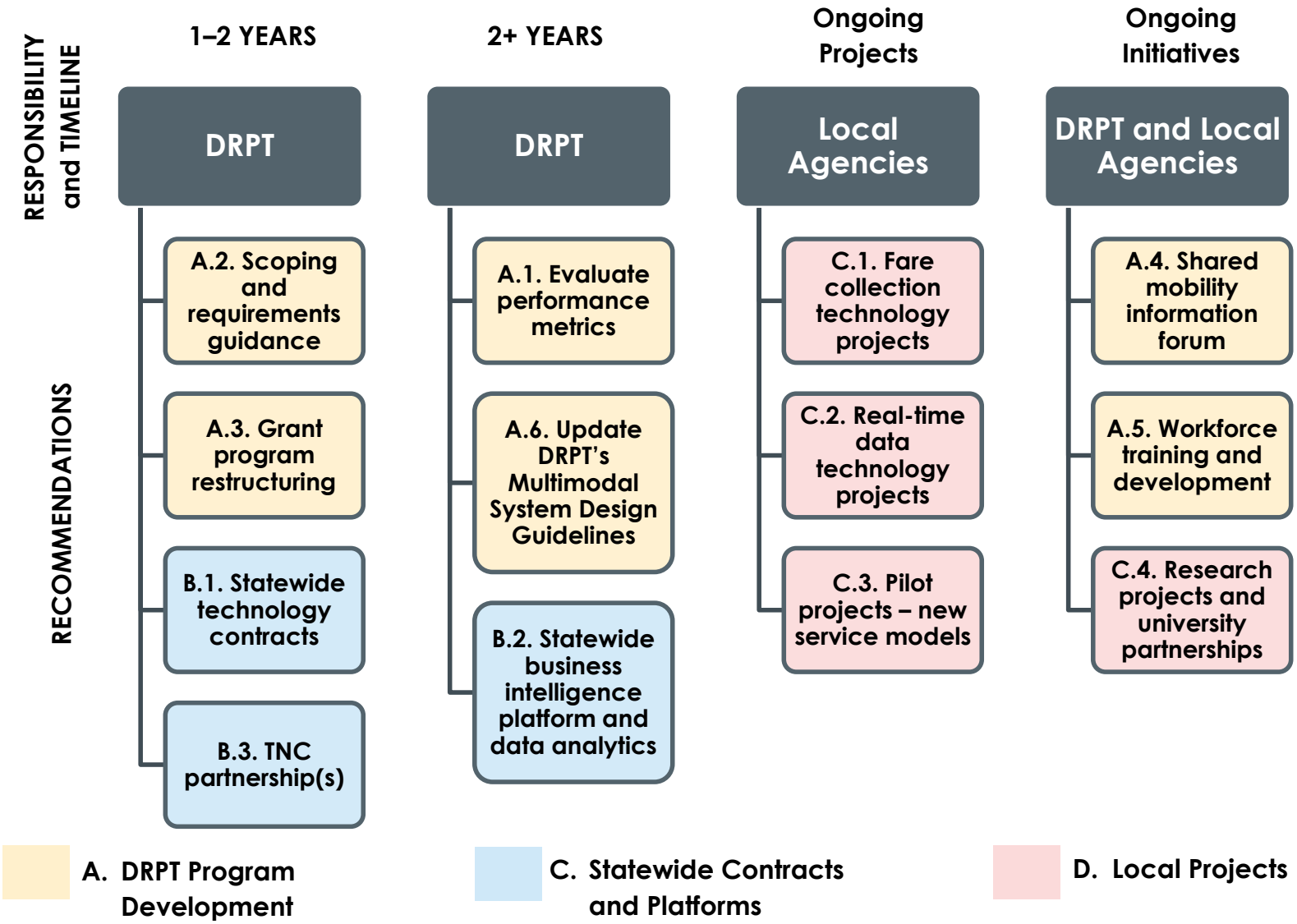
The following section details a series of recommendations for DRPT and its partner agencies on their roles in advancing integrated mobility in the Commonwealth. These recommendations have been compiled based on the review of domestic and international best practices (Section 2) and an assessment of the state of play across DRPT's partner agencies (Section 3). These recommendations have been grouped into three categories:

- **Group A: DRPT Program Development** – These are recommendations intended to be implemented by DRPT, in coordination with partner agencies and other stakeholders, to advance integrated mobility statewide
- **Group B: Statewide Contracts and Platforms** – These are recommendations for mechanisms which would be implemented by DRPT but ultimately tapped into by the partner agencies, including partnerships with TNCs and statewide contracts for technology platforms
- **Group C: Local Projects** – These are recommendations for projects that would be implemented by one or more partner agencies who are seeking to champion pilots for new service models or technologies

An initial set of recommendations was presented to stakeholders at workshops in fall 2018. During these workshops, stakeholders provided input as to their (or their agency's) level of interest and support for each recommendation. Based on this input, the recommendations have been numbered in order of DRPT and stakeholder priority. For example, recommendation A.1 (evaluating performance metrics) is the highest priority recommendation from Group A.

Figure 17 shows a listing of all recommendations grouped according to the three categories described above as well as anticipated implementation timeline. At the end of this section, each of the recommendations is laid out in more detail, including an overview and expected outcomes, expected partners, implementation timeline, and anticipated investment needs. Where applicable, similar examples from around the country or world are also provided.

Figure 17. Recommendations Summary



4.2 Investment Needs

The recommendations provided in this chapter will require some investment including DRPT staff time and external costs such as vendor or technical assistance. For each page detailing individual recommendations in this chapter, high-level funding and overall investment needs for each of the recommendations are provided.

For the most near-term initiatives—those shown in **Figure 17** as taking place in the next 1–2 years (Fiscal Year [FY] 2020 and FY2021)—it is estimated that the following resources will be needed:

Recommendation: A.2. Scoping and Requirements Guidance
Estimated DRPT Staff time – 40 hours
Estimated External Costs – $60,000–$120,000
Technical assistance estimated at $7,500 to $15,000 per agency. At an estimated four requests per year, this would be a total investment of $30,000 to $60,000 per year over 2 years.

Recommendation: A.3. Grant Program Restructuring
Estimated DRPT Staff time – 40–80 hours
Estimated External Costs – N/A

Recommendation: B.1. Statewide Technology Contracts
Estimated DRPT Staff time – 40–80 hours
Estimated External Costs – $40,000–$80,000
This would likely consist of technical assistance to develop requirements and state contracts estimated at $40,000 to $80,000 per technology. DRPT staff time would also be required for the procurement and selection process (estimated 80 to 160 hours per procurement).

Recommendation: B.3. TNC Partnerships
Estimated DRPT Staff time – 80–120 hours
Estimated External Costs – $300,000–$600,000
Costs for such a partnership will include app/technology development with the partner TNC company(s); implementation, marketing, and evaluation; and costs for the service itself paid to the partner TNC company(s), typically at market rate with separate contracts for accessible service. Comparison partnerships in the past few years have been funded in the $300,000 to $600,000 range, for a pilot period of 6 months to a year

Recommendation	DRPT Staff Time (hr)	External Costs
A.2. Scoping and Requirements Guidance	40	$60,000–$120,000
A.3. Grant Program Restructuring	40–80	N/A
B.1. Statewide Technology Contracts	80–160	$40,000–$80,000
B.3. TNC Partnership(s)	80–120	$300,000–$600,000
Total	**200–320**	**$400,000–$800,000**

4.3 Partners

Integrated mobility is an ongoing area of research and discussion around the country and the Commonwealth. As noted in the recommendations, DRPT and its partner agencies have a multitude of partners at the national, state, and local level who share an interest in transforming mobility options. This

section reiterates DRPT's and its partner agencies in implementing the recommendations in this report.

4.3.1 National Partners

Federal Transit Administration (FTA) DRPT partner agencies specifically noted in the stakeholder survey that compliance with FTA regulations and reporting is a concern when considering partnering with shared mobility providers. There is a need for FTA to provide further guidance on how shared mobility trips should be defined. FTA oversees the National Transit Database (NTD), which does not currently account for trips taken by shared mobility options and has led to concerns with ongoing shared mobility pilots around the country. There is also a need for FTA to provide guidance on use of accessible vehicles in shared mobility pilots, such as requirements for equivalent response time.

American Public Transportation Association (APTA)APTA serves public transportation agencies around the country through advocacy, innovation, and information sharing. APTA provides input to policy makers and serves as an outlet for information, hosting conferences, and publishing research.

APTA partners with FTA on the Transit Cooperative Research Program, and its website currently features a "Mobility Innovation Hub" highlighting innovative projects and resources from around the country. APTA's resources can especially be tapped into for recommendation A.4 (shared mobility information forum).

Transportation Research Board (TRB)

TRB produces and manages an extensive volume of publications and online resources. It also convenes gatherings of experts through conferences and forums. Similar to APTA, TRB's resources can and should be tapped into, especially for recommendation A.4 (shared mobility information forum).

4.3.2 State and Local Partners

Office of Innovation and Research

The Secretary of Transportation launched the Office of Strategic Innovation within the Transportation secretariat, and the Virginia Transportation Research Council (VTRC) with a focus on coordinating innovation among the Commonwealth's transportation agencies including Aviation, DRPT, Virginia Space, Virginia Port Authority, VDOT, and the Department of Motor Vehicles.

The office will work across Virginia's multimodal transportation system to identify opportunities, coordinate research, and create an entrepreneurial environment within the transportation sector. Its work will include Connected Automated Vehicle Expertise, Technology and Cybersecurity Expertise, Operations and Integration Expertise, Proven Delivery of Successful Pilot and Full-Scale Implementations, and Direct Linkage to the Virginia Transportation Research Council. The recommendations in Groups B and C, especially those related to statewide technology procurements and research projects, could look to tap into this office's resources.

Virginia Department of Transportation (VDOT)

VDOT has established a statewide ITS architecture in addition to ITS architectures supporting its five operating regions. These architectures provide an understanding of system connectivity: what functionalities exist today and what are envisioned for the future. This includes interfaces to systems outside of VDOT,

such as transit, emergency management, and information service providers. ITS architecture provides "a common starting point for all stakeholders so that ITS solutions are not developed in a vacuum but addressed in an environment of cooperation and regional consistency." New technology deployments or systems should seek to follow VDOT's lead especially in integrating with external systems.

Transportation Demand Management (TDM) Agencies

TDM services exist throughout the Commonwealth to promote shifts in travel modes to make the entire transportation system more efficient. These agencies partner with DRPT and localities to provide services complementing already-existing public transit services. These agencies often promote the use of transportation modes that reduce single-occupancy vehicle travel. Often, they are utilized to provide incentives to travelers for modal shifts. TDM agencies offer opportunity for partnerships or promotion of new service models or technologies.

Metropolitan Planning Organizations (MPOs) and Planning District Commissions (PDCs)

MPOs and PDCs in Virginia help serve as facilitators between various local governments (e.g., independent cities and counties) as well as public transportation agencies. Given their platform of cross-jurisdictional coordination, MPOs and PDCs provide a mechanism for transit agencies to ensure that they are coordinating with all relevant aspects of the communities they serve when piloting or deploying new service models.

A.1. Evaluate performance metrics

DRPT Program Develop

Overview:

- Investigate how to best measure performance of integrated mobility services dependent on available data
- Develop service partnership agreements to ensure required data is made available to the transit agency for performance reporting
- DRPT works with FTA to define eligible ridership for integrated mobility services
- Require documented evaluation of all pilots—before and after analyses
- Explore performance measures – Customer experience and satisfaction, perception of safety, and mobility measures

Expected Outcomes:

- DRPT policy that performance for pilot and testing periods do not apply toward annual statewide operating assistance allocation, on the condition that actionable steps are taken for the pilot and testing program to establish performance metrics and collect data to compare against these metrics
- DRPT provides guidance on the level of documentation and performance metrics for integrated mobility services, including before and after measures
- DRPT provides definition for ridership measurement and reporting for integrated mobility services
- DRPT defines evaluation metrics for all pilots and programs including research and data analysis

Expected Partners:

- DRPT – Investigate and set performance measures
- Agencies – Participate in performance reporting; provide input to DRPT on setting performance measures

Timeline:

- Begin in 2+ years

Stakeholder Interest:

Not Interested/ Not Applicable | Interested | Very Interested

Interested	Very Interested
31%	69%

Anticipated Investment Needs:

- To be determined given ongoing discussions; costs undefined at this time

Examples:

- Research on current and recent shared mobility pilot programs in which transit agencies partner with TNCs has noted that "the lack of analysis of performance of most partnerships […] stands as a significant barrier to the development of new ones"
- Centennial, CO, conducted an extensive audit of its Go Centennial partnership with Lyft and Via to provide free rides between a light rail station and a designated service area. This audit documents a series of goals and performance against goals.
- In June 2018, the FTA provided plans for how independent researchers will evaluate four of the Mobility on Demand (MOD) public transportation projects on performance

A.2. Scoping and requirements guidance

DRPT Program Develop

Overview:

• DRPT guidance to transit agencies on procurement of technology and transportation services – Scoping, working with procurement office, selection
• Frameworks for experimenting and testing
• Technical assistance for procurement and implementation process
• Guidance on data sharing
• Guidance on legal and liability issues around integrated mobility

Expected Outcomes:

• Agencies are better educated in writing specifications and statements of work
• Increased awareness of challenge areas and ways to address these
• Standardization of procurement approaches
• Improved contracts utilizing prior lessons learned

Expected Partners:

• DRPT – Develop guidance and facilitate information dissemination
• Agencies – Apply guidance in the procurement of technology and integrated mobility services/partnerships

Timeline:

• Begin in 1–2 years

Stakeholder Interest:

Not Interested/ Not Applicable | Interested | Very Interested

Interested	Very Interested
36%	64%

Anticipated Investment Needs:

• This would likely consist of guidance to individual agencies via technical assistance
• Technical assistance estimated at $7,500 to $15,000 per agency. At an estimated four requests per year, this would be a total investment of $30,000 to $60,000 per year.

Examples:

• The Shared-Use Mobility Center's (SUMC) On-Ramp Program, a partnership with FTA, provides "expert assistance" to public transportation agencies to develop business plans and project-building strategies (agencies must apply and be selected)

A.3. Grant program restructuring

DRPT Program Develop

Overview:

- Restructure existing grant programs to direct funds and be more conducive to technology and integrated mobility projects (Demonstration Project Assistance and Technical Assistance)
- Provide support for feasibility studies, planning, and establishing the business case for integrated mobility project applications
- Promote and encourage application to external grant programs
- Include technical assistance with capital assistance grants for implementation and project management

Expected Outcomes:

- Increased use of existing Special Project grants for technology and integrated mobility projects
- Funds to support deployment of new systems and services
- Technical assistance for all statewide platforms and deployments

Expected Partners:

- DRPT – Grant administrators
- Office of Research and Innovation
- Agencies – Apply for grants and grant recipients; implement projects with funds

Timeline:

- Begin in 1–2 years (new structure FY2021)
- Annual grant awards following the current DRPT grant schedule

Stakeholder Interest:

Anticipated Investment Needs:

- This initiative would be led internally by DRPT staff

Examples:

External grant programs and funding sources include –

- Regional transportation funding programs, such as Northern Virginia Transportation Authority (NVTA) and Hampton Roads Transportation Accountability Commission (HRTAC)
- State-level transportation funding programs outside of DRPT, such as Smart Scale or the I-66 TMP
- Federal programs, such as the BUILD discretionary grant program (formerly TIGER grant program), Federal Highway Administration's Advanced Transportation and Congestion Management Technologies Deployment (ATCMTD) program, and FTA's MOD Sandbox program

A.4. Shared mobility information forum

DRPT Program Develop

Overview:
- Establish forum to facilitate information sharing and experience with shared mobility projects and to follow national trends
- Regular in-person or web-based meetings
- Initially, use DRPT technology roundtable as forum
- Invite presenters from other U.S. agencies to share lessons learned
- Potential agenda topics – Microtransit, fare payment applications, findings from feasibility studies, ongoing research in Virginia, latest from national organizations (e.g., APTA, FTA, TRB, and SUMC)
- Could be organized based on geography, technology application, or vendors being used by agencies

Expected Outcomes:
- Increased skills for deploying technology and integrated mobility services
- Agencies share best practices and lessons learned
- Agencies support each other

Expected Partners:
- DRPT – Organize forums; allocate funding for travel
- Agencies – Participate in forums; provide feedback on topics and meeting frequency; document outcomes and provide to DRPT; host information forums
- MPOs – Participate in forums
- Private sector – Participate in forums, as appropriate

Timeline:
- Ongoing initiative; frequency of forums is on an as-needed basis as determined by agencies

Stakeholder Interest:

Anticipated Investment Needs:
- This initiative would be led internally by DRPT staff. Approximately 40 hours per year of staff time is estimated including forum set-up, logistics, coordination, and facilitation

Examples and Potential Forums:
- Ongoing Virginia Transit Technology Roundtable, typically held twice annually
- Within Virginia – System Operations Research Advisory Committee (SORAC) and Transportation Planning Research Advisory Council (TPRAC); Virginia Transit Association (VTA) Annual Conference; Intelligent Transportation Society of Virginia (ITSVA)
- External to Virginia – National Shared Mobility Summit (held by SUMC); Future of Mobility Summit (held by APTA)

A.5. Workforce training and development

DRPT Program Develop

Overview:

- Provide and support training programs for transit agency staff
- Provide technology and integrated mobility 101 courses
- Bring in National Transit Institute (NTI) to provide Virginia training courses – Managing Community Mobility, Systems Engineering for Technology Projects, Transit ITS Seminar, Procurement for Small and Medium Transit Systems, and Implementing Rural Transit Technology
- Financial support for transit agency staff to attend conferences
- Statewide account to online training site for self-paced videos (e.g., Lynda.com)
- Continue to invest in Public Transportation Intern Program
- Establish technical assistance phone number to get on-call support services with technology systems

Expected Outcomes:

- Increased skills for deploying and maintaining technology
- Increased agency and public education on integrated mobility
- Access to on-demand and classroom training
- Greater access to on-call technical assistance

Expected Partners:

- DRPT – Organize training opportunities; allocate funding for travel and training programs
- VTA – Webinars; education courses; annual conference
- Agencies – Participate in training courses; facilitate information sharing internally and externally

Timeline:

- Ongoing initiative

Stakeholder Interest:

Not Interested/ Not Applicable	Interested	Very Interested
14%	50%	36%

Anticipated Investment Needs:

- This initiative would be led internally by DRPT staff but would include coordination to host NTI courses, which are free to transit agencies and state/local government staff. Approximately 40 hours per year of staff time is estimated including coordinating course logistics and facilitation. Minimal ongoing costs are anticipated for DRPT and agency staff to attend training courses.

Examples:

- NTI (at Rutgers, the State University of New Jersey) provides training, education, and clearinghouse services
- Encourage and expand use of Technical Assistance grants to cover in-house or travel training related to transit technology and integrated mobility

A.6. Update DRPT's Multimodal System Design Guidelines

DRPT Program Develop

Overview:

- Update guidelines to include shared mobility; include services, amenities, and technologies that make up a mobility hub
- Emphasize design guidelines for improving competitiveness of bus transit, including transit signal priority (TSP), queue jumps, and dedicated bus lanes
- Engage MPO partners

Expected Outcomes:

- Holistic framework for multimodal planning with a step-by-step process for planning and implementation

Expected Partners:

- DRPT – Lead update and promote use of guidelines
- Agencies and localities – Users of guidance in planning transportation networks

Timeline:

- Begin in 2+ years

Stakeholder Interest:

Not Interested/ Not Applicable	Interested	Very Interested
15%	54%	31%

Anticipated Investment Needs:

- This would consist of a $50,000 to $100,000 technical assistance effort to update the design guidelines

Examples:

- The current guidelines were completed in October 2013
- San Diego Association of Governments (SANDAG) have a Regional Mobility Hub Implementation Strategy which provides implementation considerations and a features catalog

B.1. Statewide technology contracts

Statewide Contracts and Pla

Overview:

- Statewide contract for ITS deployment and implementation/operation support services
- Develop standard specifications, work with DRPT procurement staff to develop Invitations to Bid, and award the contracts
- Develop a repository of existing contracts and specifications as an initial step, and provide as templates
- Potential systems include automated passenger counters (APCs), computer-aid dispatch/automated vehicle location (CAD/AVL), mobile data terminals (MDTs), electronic registering fareboxes (ERFs), cameras, scheduling software, mobile ticketing/mobility as a service (MaaS) platform applications
- Develop a working group to help shepherd the initiative and get agency buy-in

Expected Outcomes:

- State contracts for ITS with pricing schedules
- Agencies have option to purchase from the DRPT contract
- Overall mechanism for better competition and unit pricing
- Standardization of ITS procurement statewide
- Efficiencies in training, technical assistance, and enhancements for agencies buying similar equipment
- Improved potential for peer agency support and assistance

Expected Partners:

- DRPT – Facilitate development of state contracts
- Agencies – Users of state contract, provide input during specification development
- Vendors – Bidders to state contract, provide input during specification development

Timeline:

- Begin development of state contract in year 1 (priorities are CAD/AVL, mobile ticketing, and scheduling software)
- 6–8 months to develop state contract
- Contract up for renewal every 3 years
- Evaluate, revise, and reissue contract every 3 years

Stakeholder Interest:

Anticipated Investment Needs:

- Staff time and resources to develop requirements and state contracts estimated at $40,000 to $80,000 per technology
- DRPT staff time would also be required for the procurement and selection process (estimated 80 to 160 hours per procurement)

Examples:

- DRPT MobileEye state contract and bus contracts

B.2. Statewide business intelligence platform and data analytics

Statewide Contracts and Pla

Overview:

- Implement statewide platform for data analysis and business intelligence
- Platform used to assist with trend analysis, strategic planning, and local and state analyses
- Initial exploratory analysis to inventory existing data sources and format and establish use cases (what questions do we want answered by the data?)
- Start by integrating data and reporting metrics common among most agencies

Expected Outcomes:

- Agencies have more time to focus on delivering service
- Less redundancies and cost compared to each agency having their own business intelligence tool
- Smaller agencies can leverage investments made by larger agencies
- Recommendations provided to agencies for improving service efficiency
- Increased transparency in data and performance
- Data format standards

Expected Partners:

- DRPT – Procures and manages the platform; establishes standard data format; performs regular data analysis
- Agencies – Data supplier (may require modifications to data collection platforms); identify needs; recipient of analysis results and recommendations; access tool for additional analysis if desired
- Vendor – Platform supplier and integrator; provides training and support

Timeline:

- Begin in 2+ years

Stakeholder Interest:

Not Interested/ Not Applicable | Interested | Very Interested

Interested	Very Interested
36%	64%

Anticipated Investment Needs:

- This platform is estimated at $500,000 to $1 million ultimately depending on specifications and advancements in technology. This estimate includes integration of existing data feeds, data storage/warehouse, and analytics and visualization tools with support for generating performance metrics.

Examples:

- Software/interface to Online Grant Administration site (OLGA) to allow for agencies to review trends in data agencies have submitted to DRPT

B.3. TNC partnership(s)

Statewide Contracts and Pla

Overview:

- Statewide or regional contracts for service partnerships with TNCs to streamline local partnerships
- Service models for different geographic areas – Rural, suburban, small urban
- Potential service types – Paratransit service, microtransit, and first/last mile service
- Statewide data sharing agreements
- Establish working group made up of representatives from agencies of different sizes to assist DRPT in establishing partnership details

Expected Outcomes:

- Easier implementation of partnerships at the local level
- Leveraging of stateside buying power to obtain reasonable terms on data sharing and pricing strategies
- Multiple service models for scalability and repeatability in various locations statewide
- Outcomes are evolving

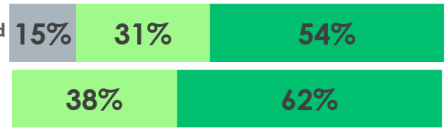
Expected Partners:

- DRPT – Establish statewide agreement with TNC(s)
- Agencies – Implement service partnerships; data sharing recipient
- TNC(s) – Service provider; data supplier

Timeline:

- Begin in 1–2 years

Stakeholder Interest:



Anticipated Investment Needs:

- Costs for such a partnership will include app/technology development with the partner TNC company(s); implementation, marketing, and evaluation; and costs for the service itself paid to the partner TNC company(s), typically at market rate with separate contracts for accessible service. Comparison partnerships in the past few years have been funded in the $300,000 to $600,000 range for a pilot period of 6 months to a year.

Examples:

- Paratransit – Greater Richmond Transit Company (GRTC) partnership with reservation companies (UZURV and Roundtrip) which coordinate with Uber and/or Lyft for same-day paratransit services
- Orange County Transportation Authority partnership with Lyft to provide on-demand services replacing low-ridership routes
- Pinellas County (FL) subsidization of Uber trips to/from select locations (e.g. commuter rail stations)

• Data sharing agreements between public agencies and on-demand scooter companies (e.g., Kansas City, MO)

C.1. Fare collection technology projects

Local P

Overview:
• Implement projects to facilitate fare payment integration with shared mobility providers, such as through mobile ticketing
• Implement and integrate mobile ticketing regionally or statewide
• Investigate feasibility of statewide fare payment platform

Expected Outcomes:
• Improved customer convenience, including the ability to purchase bus and rail passes directly from a mobile device and use the mobile device for the on-board transaction
• Single fare payment service for customers to use any transit service across the Commonwealth reducing barriers to transit usage
• Ability for smaller agencies to take advantage of advanced electronic payment options

Expected Partners:
• DRPT – Allocate funding for fare collection projects; facilitate a potential statewide implementation of mobile ticketing
• Agencies – Implement acceptance of statewide platform for payment of trips
• Vendors – System supplier and integrator
• Private sector – Integrate transit fare payment into their applications, as appropriate
• Agencies most interested in mobile ticketing at time of report: CAT, DASH, GLTC, HRT, PRTC, WATA

Timeline:
• Ongoing projects and annual DRPT grant applications

Stakeholder Interest:
Not Interested/ Not Applicable | Interested | Very Interested

Interested	Very Interested
43%	57%

Anticipated Investment Needs:
• The cost drivers for mobile ticketing are ongoing transaction fees (typically 7–10 percent of fares collected), agency staff time, validator hardware, and annual maintenance and software hosting fees. Vendors often offer implementation at no upfront costs other than the cost of hardware and any custom app development or integrations.
• Investment will be needed on a per-agency basis and is estimated to be $100,000 for initial application development, $500 to $2,500 per validator (bus), annual maintenance fees of $500 to $1,000 per bus, and annual transaction fees of 7–10 percent of mobile ticketing fare revenue

Examples:
• Virginia Railway Express (VRE) mobile ticketing program (and plans to link mobile ticketing app with other shared mobility services for first/last mile connections
• NVTC Regional Fare Collection Program looking at a coordinated regional platform for mobile ticketing
• PRTC planned initiative to partner with reservation platform service for paratransit booking

• Pilots of mobile ticketing validation services for bus passes (e.g., Token Transit)

C.2. Real-time data technology projects

Local Pr

Overview:

• Implement projects to facilitate transit agency data sharing with shared mobility providers, including data collection systems (e.g., CAD/AVL) and data feeds (e.g., application programming interfaces [APIs]), General Transit Feed Specification Real Time (GTFS-RT)
• Projects should facilitate integration and data sharing with third-party applications
• Regionally integrate data systems
• Data feeds into statewide platform (recommendation B.2)

Expected Outcomes:

• Continued investment in transit technology foundation
• All DRPT transit agencies make real-time bus location data publicly available (exceptions made for those in rural areas with poor cellular reception)
• Make use of existing systems and third-party mobile app providers
• Use of standard data format (GTFS-RT) provides access to third-party tools and visualization

Expected Partners:

• DRPT – Allocate funding for real-time data technology projects
• Agencies – Implement and upgrade data collection systems
• Vendors – System supplier and integrator
• Private sector – Integrate transit data feeds into their applications, as appropriate
• Agencies with near-term plans to implement GTFS-RT at time of report: BT, WinTrans, HRT, LCT, PRTC, Valley Metro

Timeline:

• Ongoing projects and annual DRPT grant applications

Stakeholder Interest:

Anticipated Investment Needs:

• Investment will be needed on a per-agency basis for those who have not set up a GTFS-RT feed. This is estimated at $10,000 per agency if an agency already has an AVL system up and running. Agencies should also scope this update into any larger AVL upgrade or procurements.

Examples:

• Agencies making GTFS-RT feeds publicly available via an API or developer portal to allow for third-party app development
• Singapore Intelligent Transportation System monitoring and managing public transportation dynamically

C.3. Pilot projects – new service models

Local P

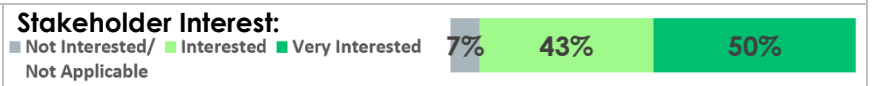
Overview:
- Implement pilot projects for new service models, including flex service, microtransit, first/ last mile, and shuttles
- Projects should strive to scalable and repeatable in other Virginia communities
- Projects should include an established business case, evaluation (before and after analyses), data collection and sharing, sharing of lessons learned to Virginia agencies

Expected Outcomes:
- Virginia becomes a testing ground for various service models and applications, including a mix of urban, suburban, and rural applications
- Data from these pilots is publicly available and lessons learned are documented in detail and shared with external stakeholders

Expected Partners:
- DRPT – Allocate funding for pilot projects
- Agencies – Implement pilot projects; potential service operator
- Vendors/private sector – Potential service operator
- Most interested agencies at time of report: HRT, Fairfax Connector

Timeline:
- Ongoing projects and annual DRPT grant applications

Stakeholder Interest:



Anticipated Investment Needs:
- Costs for such a program will include app/technology development; implementation, marketing, and evaluation; and costs for the service itself (which could include capital costs for vehicles in addition to operations, whether contracted out or conducted in-house). Comparison pilots for new service models in the past few years have been funded at approximately $1 Million or more, for a pilot period of 6 months to a year.
- Note that if replacing existing service, it is possible for new service models such as flexible on-demand bus service to be revenue-neutral or more cost-efficient than services they are replacing (e.g., AC Transit Flex service)

Examples:
- PRTC flexible vanpool service for I-66 Commuter Choice Program
- AC Transit (Oakland, CA) flex service in areas that had low transit demand previously

C.4. Research projects and university partnerships

Local Pl

Overview:

- Implement and support further research in integrated mobility projects with Virginia university partners
- Universities work through DRPT to find partner agency and vice versa
- Potential research questions include (from TRB) –
  - Investigating which first/last mile solutions are best for specific environments and stops
  - Determining a methodology to collect and analyze the number of pickups and drop-offs from new modes such as TNCs and microtransit
  - Researching travelers' acceptance of shared mobility (e.g., likelihood of travelers to ride in a vehicle where they don't know fellow travelers)
  - Examining which shared use services are efficient and cost-effective for rural (low-density) areas, who should operate or dispatch, and how technology can be used to facilitate

Expected Outcomes:

- Training future workforce about the industry
- Utilization of university staff for research, data mining/processing
- Presentation of research findings at shared mobility information forums (recommendation A.4)

Expected Partners:

- DRPT – Facilitate partnerships between researchers and transit agencies; assist in identifying research questions
- Agencies – Implement pilot projects; potential service operator
- Universities – University of Virginia, Virginia Tech, George Mason University, Old Dominion University, Virginia Military Institute, etc.

Timeline:

- Ongoing initiative

Stakeholder Interest:

Not Interested/ Not Applicable	Interested	Very Interested
14%	43%	43%

Funding:

- This initiative would be facilitated internally by DRPT staff, estimated at approximately 80 hours per year

Examples:

- Making transit CAD/AVL, APC, or farebox data available to external partners such as the VTRC/Virginia Tech Transportation Institute (VTTI), University of Maryland's Center for Advanced Transportation Technology, the University of Virginia Smart Travel Lab, etc.
- VTTI's Center for Public Policy, Partnerships, and Outreach works to inform policy "on a wide range of issues related to transformational transportation technology." Most of their research is currently focused on connected/autonomous vehicles.
- The Transportation Sustainability Research Center at the University of California, Berkeley, has been involved with research specifically relating to shared mobility, including recent whitepapers on the Future of Mobility and Planning for Shared Mobility
- SUMC is a non-profit research center based in Chicago and Los Angeles focused on shared mobility

REFERENCES

Aapaoja, A., Eckhardt, J., Nykänen, L., & Sochor, J. (2017, November). MaaS service combinations for different geographical areas. In Presented at the 24th World congress on intelligent transportation systems, Montreal, 29 October-2 November 2017.

Baldassari, E. (2017, March 25). The newest battleground between public transit and Uber, Lyft is an unlikely one. Retrieved from https://www.mercurynews.com/2017/03/24/the-newest-battleground-between-public-transit-and-uber-lyft-is-an-unlikely-one

Calzada, I. (2018). (Smart) Citizens from Data Providers to Decision-Makers? The Case Study of Barcelona. Sustainability, 10(9), 3252.

Descant, S. 2018. Transit and Ride-Sharing Partnerships on the Rise, Despite Growing Pains. Retrieved from http://www.govtech.com/fs/transportation/Transit-and-Ride-Sharing-Partnerships-on-the-Rise-Despite-Growing-Pains.html

CB Insights (2018, September 5). Disrupting the car: How shared cars, bikes, & scooters are reshaping transportation and cannibalizing car ownership. Retrieved from https://www.cbinsights.com/research/disrupting-cars-car-sharing-scooters-ebikes/

Federal Motor Carrier Safety Administration. Interstate Passenger Carrying Driver's Guide to Hours of Service. (no date, but ca 2014). FMCSA website.

Flex V. Fixed: An Experiment in On-Demand Transit. (2018, May 15). Retrieved September 24, 2018, from https://transitcenter.org/2018/05/15/adding-flexible-routes-improve-fixed-route-network/

Government Accountability Office (GAO) (2018). Public transit partnerships. Retreived from https://www.gao.gov/assets/700/693518.pdf

Greater Richmond Transit Company (2018). CARE On-Demand. Retrieved from http://ridegrtc.com/services/specialized-transportation/care-on-demand

Grisby, D., Dickens, M., MacPherson-Hughes, C. (2018). Understanding recent ridership trends. Retrieved from https://www.apta.com/resources/reportsandpublications/Documents/APTA-Understanding-Recent-Ridership-Changes.pdf

HART launches HyperLINK program. (2017, May 02). Retrieved from http://www.bikewalktampabay.org/featured/hart-launches-hyperlink-program/

Hill, N., Gibson, G., Guidorzi, E., Amaral, S., Parlikad, A. K., & Jin, Y. (2017). Scoping Study into Deriving Transport Benefits from Big Data and the Internet of Things in Smart Cities.

Ho, B., & Bright, U. (2018). TRANSPORTATION REIMAGINED.

Ho, C., Hensher, D. A., Mulley, C., & Wong, Y. Z. (2017, August). Prospects for switching out of conventional transport services to mobility as a service subscription plans–a stated choice study. In Presented at Thredbo15-International conference series on competition and ownership in land passenger transport, Stockholm, 14-18 August, 2017.

Hook, W., & Hughes, C. (2017). Best Practice in National Support for Urban Transportation: Part 2: Growing Rapid Transit Infrastructure—Funding, Financing, and Capacity.

Hyatt, K. (2018, June 13). Waymo's Phoenix pilot program is a year old, so how is it going? Retrieved from https://www.cnet.com/roadshow/news/2018-waymo-phoenix-arizona-self-driving-car-pilot-program-one-year/

Kaewunruen, S., Sussman, J. M., & Matsumoto, A. (2016). Grand challenges in transportation and transit systems. Frontiers in built environment, 2, 4.

Klein, N. J., & Smart, M. J. (2017). Millennials and car ownership: Less money, fewer cars. Transport Policy, 53, 20-29.

König, D., Eckhardt, J., Aapaoja, A., Sochor, J. L., & Karlsson, M. (2016). Deliverable 3: Business and operator models for MaaS. MAASiFiE project funded by CEDR. Submitted to: CEDR Conference of European Directors of Roads.

Lam, C., & Liu, M. (2018). More than Taxis with An App: How Ride-hailing Platforms Promote Market Efficiency.

McCoy, K., Andrew, J., Glynn, R., & Lyons, W. (2018). Integrating Shared Mobility into Multimodal Transportation Planning: Improving Regional Performance to Meet Public Goals (No. DOT-VNTSC-FHWA-18-13; FHWA-HEP-18-033). United States. Federal Highway Administration. Office of Planning, Environment, and Realty.

Menzel, G., Böhm, M., & Zwick, K. (2014, April). Deployment of Interoperable Cross-Border Multimodal Traveller Information in Central Europe. In Transport Research Arena (TRA) 5th Conference: Transport Solutions from Research to Deployment European Commission Conference of European Directors of Roads (CEDR) European Road Transport Research Advisory Council (ERTRAC) WATERBORNE European Rail Research Advisory Council (ERRAC) Institut Francais des Sciences et Technologies des Transports, de l'Aménagement et des Réseaux (IFSTTAR) Ministère de l'Écologie, du Développement Durable et de l'Énergie.

Moran, M., Ettelman,B., Stoeltje,G., Hansen,T. (2017). Policy Implications of Transportation Network Companies.

Moran, M., & Lasley, P. (2017). Legislating Transportation Network Companies. Transportation Research Record: Journal of the Transportation Research Board, (2650), 163-171.

Pew Research Center. Mobile Fact Sheet. February 5, 2018. Pew Research Center website, http://www.pewinternet.org/fact-sheet/mobile/

Reimagining Public Transit in San Clemente. (2016, October 10). Retrieved from https://blog.lyft.com/posts/reimagining-public-transit-in-san-clemente

Rode, P., Floater, G., Thomopoulos, N., Docherty, J., Schwinger, P., Mahendra, A., & Fang, W. (2017). Accessibility in cities: transport and urban form. In Disrupting mobility (pp. 239-273). Springer, Cham.

San Francisco County Transportation Authority, "TNCs and Congestion: Draft Report," October 2018

Shaheen, S., Chan, N., & Rayle, L. (2017). Ridesourcing's impact and role in urban transportation.

Shaheen, S., Bell, C., Cohen, A., & Yelchuru, B. (2017). Travel Behavior: Shared Mobility and Transportation Equity (No. PL-18-007).

Shaheen, S., Stocker, A., Lazarus, J., & Bhattacharyya, A. (2016). RideKC: Bridj Pilot evaluation: impact, operational, and institutional analysis. Transportation Sustainability Research Center (TSRC), UC Berkeley.

Shcwieterman, J., Livingston, M. (2018). Partners in Transit

Smith, G., Sochor, J., & Karlssona, M. (2017). Mobility as a Service: Implications for future mainstream public transport.

Susan, S., Cohen, A., Zohdy, I. (2017). Shared Mobility: Current Practices and Guiding Principles.

Touring Bishop Ranch Autonomous shuttle pilot - what will it take to go mainstream? (2017, July 19). Retrieved from http://www.greencaltrain.com/2017/07/touring-bishop-ranch-autonomous-shuttle-pilot-what-will-it-take-to-go-mainstream/

Transit and Ride-Sharing Partnerships on the Rise, Despite Growing Pains. (2018, August 20). Retrieved from http://www.govtech.com/fs/transportation/Transit-and-Ride-Sharing-Partnerships-on-the-Rise-Despite-Growing-Pains.html

Uber and Altamonte Springs launch pilot program to improve transportation access | Uber Blog. (2016, March 21). Retrieved from https://www.uber.com/blog/orlando/altamonte-springs/

US Department of Labor. Mass Transit Employee Protections 49 U.S.C. § 5333(b). US DOL website, checked February 19, 2018. https://www.dol.gov/olms/regs/compliance/compltransit.htm

Virginia Department of Transportation. VDOT website, checked January 17, 2019. http://www.vdot-itsarch.com/

Virginia Department of Transportation. VDOT website, checked January 17, 2019. http://www.virginiadot.org/VDOT/Business/asset_upload_file1_3638.pdf

Waddell, K. (2018, December 09). The true cost of autonomous cars. Retrieved from https://www.axios.com/who-will-pay-for-autonomous-vehicles-11702624-0fbf-4b5f-9d3a-bf5c4cd3ed8a.html

WMATA (2017, October 12). Understanding rail and bus ridership. Retrieved from https://www.wmata.com/about/board/meetings/board-pdfs/upload/3A-Understanding-Ridership-TO-POST.pdf

Westervelt, M., Schank, J., & Huang, E. (2017). Partnerships with Technology-Enabled Mobility Companies: Lessons Learned. Transportation Research Record: Journal of the Transportation Research Board, (2649), 106-112.

Wisniewski, M., & Lee, W. (2016, December 15). Metra reaches deal with Uber for marketing, while rival Lyft expands. Retrieved from http://www.chicagotribune.com/news/local/breaking/ct-metra-uber-deal-lyft-expansion-20161214-story.html

Xu, W., Guthrie, A., Fan, Y., & Li, Y. (2017). Transit-oriented development in China: Literature review and evaluation of TOD potential across 50 Chinese cities. Journal of Transport and Land Use, 10(1), 743-762. Retrieved from http://www.jstor.org/stable/26211754

Ziaee Bigdeli, A., Bustinza, O. F., Vendrell-Herrero, F., & Baines, T. (2018). Network positioning and risk perception in servitization: evidence from the UK road transport industry. International Journal of Production Research, 56(6), 2169-2183.

APPENDICES

Appendix A: Additional Shared Mobility Examples

Appendix B: Stakeholder Survey Summary

Appendix C: Transit Technology Acronym Guide

Appendix A: Additional Shared Mobility Examples

This section provides additional examples of where agencies have implemented integrated mobility solutions.

Chattanooga Area Regional Transportation Authority (CARTA)

CARTA is the implementing a microtransit pilot to replace two existing Dial-a-Ride routes. The microtransit service will be operated by CARTA using the agency's vehicles and employees. It will be augmented by on-demand technologies supplied by an undisclosed private partner (CARTA was engaged in contract negotiations at the time of publishing this report).

The target audience of the pilot is customers living within the current Dial-a-Ride service areas where more than 75 percent have indicated that they cannot drive or have no access to another transportation mode. These users have also been identified as the most likely to need to transfer between two to three buses to complete their trips. Fixed route service is not provided in these areas of the city due to inefficient street connectivity and low development densities. Poor walking infrastructure also hinders access to fixed stops. One of the zones is primarily residential, while the other serves as a mix of land uses including commercial residential.

During the pilot, each Dial-a-Ride route will be replaced with a zone, within which customers will be able to book on-demand trips. The microtransit service will connect to CARTA's conventional bus network at two suburban shopping centers that serve as existing transfer areas for Dial-a-Ride. The microtransit pilot will provide continuity from the Dial-a-Ride service model by allowing call-in bookings for customers without smartphones. The microtransit vehicles will be scheduled to serve the transfer areas to facilitate transfers with fixed routes, allowing customers to board the vehicle without booking a trip.

Detailed evaluation metrics for the pilot are in development. Key aspects identified for evaluation are mobility (which may focus on accessibility, ridership, and/or system utilization) and CARTA operations (which may focus on revenue, staffing needs, and/or costs). Once key performance indicators have been established, they will be tracked using data available from the microtransit dispatching technology and CARTA operations.

Greater Dayton Regional Transit Authority (GDRTA)

GD RTA currently provides RTA Connect service in partnership with Lyft to customers previously served at eliminated stops. Riders can request rides from transit centers located at the route end-points to a location within the GDRTA service area. As GDRTA plans to expand its service area from Montgomery County to an 11-county region, it is developing mobility as a service (MaaS) platform for the Greater Dayton region as part of its efforts to upgrade its existing fare collection system and offer an integrated payment system. At the same time, the agency is implementing a 1-year microtransit pilot with TransLoc that will provide on-demand service to customers. The pilot is currently in the testing phase. To share insights and lessons learned regarding microtransit pilots and potential MaaS visions, CARTA and RTA are meeting on a regular basis.

Kansas City Area Transportation Authority (KCATA)

KCATA is in the process of implementing its second on-demand pilot as part of its Kansas City RideKC Freedom On-Demand project. The project originally leveraged a public-private

partnership with the microtransit company, Bridj (which has since discontinued operations). The 1-year pilot program was launched in March 2016, and included a mobile application offering same-day service. The target audience of the first pilot was commuters because Bridj offered a solution designed for commute patterns where service was only provided in the direction of demand. This was the first time an agency worked with Bridj using public funding. The pilot also included 10 Ford Transit shuttle buses, representing one of the first partnerships in the industry between a major automobile provider, transit agency, and private microtransit company.

KCATA and Bridj worked together to define the zones for the service, which offered trips to customers for $1.50 during weekday rush hours. Ridership for the first 6 months of the pilot was low. Overall, 1,200 trips were not accepted as they were outside the zones and/or hours of service. In the last 6 months, ridership increased slightly as a result of a partnership with the hospital, KUMed, where parking was limited. Looking back, KCATA noted that the pilot did not meet the needs of the KCATA customers within the geographies selected.

KCATA launched a second on-demand project with TransDev on May 1, 2017, once again with the RideKC Freedom mobile application. The mobile application offers a user-friendly, map-based trip-booking interface. In the future, KCATA plans to expand their technical developments to integrate mobile fare payment with the RideKC Freedom On-Demand application. The KCATA pilots represent commuter and urban circulator delivery models. In cities without major congestion, incentivizing people to use transit by highlighting the reduced need to park may help promote microtransit use.

Livermore Amador Valley Transit Authority (LAVTA)

LAVTA is providing residents traveling within the city limits of Dublin, CA, with options for first/last mile trips through partnerships with Uber, Lyft, and Desoto Cab Company. The pilot promotes ridesplitting, leveraging UberPOOL, Lyft Line, and Desoto Share. Residents use a promo code to access the service where half of customers' fare, up to $5, is paid for by the agency. The service represents a low-density zone-based model with 10- to 15-minute wait times.

Partners must provider background checks, DMV checks, vehicle inspections and $1 million in liability insurance. To measure success, LAVTA will receive data such as anonymous users' frequent destinations, peak travel times, and other non-address specific information. Not all services are accessible for people without smartphones and accessible vehicle requirements, with Desoto providing the only call-in options, wheelchair access, and cash payment option.

Research Triangle Regional Public Transportation Authority (GoTriangle)

GoTriangle's pilot with Uber and TransLoc was one of the first public-private partnerships. TransLoc provided consolidated information and trip planning where residents could enter a destination and receive a trip itinerary including public transit and Uber, if necessary, to reach the transit station. People could also see real-time travel times within the application. During times when transit was not available, customers could still plan trips with Uber as an option. GoTriangle saw a 26 percent increase in ridership as a result of consolidated information, according to TransLoc.

Sacramento Regional Transit District (RT)

Sacramento RT is an example of a public microtransit pilot titled SmaRT ride through a partnership with TransLoc, which is providing on-demand software. The pilot launched in February 2018, upgrading the existing Dial-a-Ride service. The agency hopes to maintain fares at the same levels as its conventional transit service.

York Region Transit (YRT)

YRT is a leader in the Family of Services (FoS) initiative, moving eligible customers to in-house on-demand microtransit provided by Routematch. YRT upgraded their specialized transit scheduling, dispatch, and customer access systems (including a web portal and mobile application). Prior to the upgrade in 2014, YRT manually planned trips for travel-trained specialized transit customers to use conventional services.

Encouraging specialized transit riders to use accessible conventional transit has increased the number of trips taken and reduced the length of specialized transit trips. The average distance has decreased from 11 km to 7.4 km. The change in business model has led to a 7 percent to10 percent growth in ridership from 1,200 trips per day to 1,500 trips per day with almost zero additional cost.

The Routematch upgrade is also intended to be used for other on-demand services. Both the specialized transit, Mobility Plus, and rural, low-density Dial-a-Ride service will be integrated as part of a united On-Demand Strategy. This is in line with consolidating all YRT services into one FoS where users may be assigned either type of vehicle depending on eligibility.

The following table provides some additional examples.

Agency	Partner	Initiative
Capital Metro (Austin, TX)	Via	Offering free on-demand service within two zones, asking simply that customers provide feedback, so Capital Metro can use it to measure the effectiveness of the pilot.
King County Metro	Non-profit transportation providers	Providing funding in exchange for partners providing a certain number of accessible rides. Examples of partners include supportive living facilities and community centers.
Lone Tree, CO	Uber (software)	Using Uber's software on existing shuttles to provide the town of 2 square miles with free, on-demand shuttle service.
Massachusetts Bay Transportation Authority (MBTA)	Uber and Lyft	Offering subsidized paratransit rides in an effort to reduce MBTA's cost per paratransit trip. There have been 10,000 Uber trips over 5 months.
Montreal System de Transport Metropolitan (STM)	Bikeshare	Offering the ability to pay for bikeshare with STM transit passes.
Orange County Transportation Authority (OCTA)	Taxi	Providing a same-day taxi mobile application for on-demand taxi service.
Sacramento, CA	Carshare	Providing residents of three public housing complexes with access to free carshare available at the complexes and nearby transit stops.
Summit, NJ	Uber	Offering free rides to and from the train station in an effort to alleviate demand for parking.

Appendix B: Stakeholder Survey Summary

AGENCY SERVICE CHARACTERISTICS AND EXECUTIVE SUPPORT

Survey Participants

- Arlington County
- Bay Transit
- Blacksburg Transit
- City of Charlottesville
- City of Winchester
- Central Shenandoah PDC - BRITE Transit
- DRPT
- Dulles Area Transportation Association (DATA)
- Fairfax County DOT
- GRTC
- Hampton Roads Transit
- Harrisonburg Department of Public Transportation
- Loudoun County
- Middle Peninsula Planning District Commission
- Northern Neck PDC NeckRide.org
- OmniRide (PRTC)
- Petersburg Area Transit
- Radford Transit
- RideFinders
- Valley Metro - Roanoke
- WATA
- WMATA

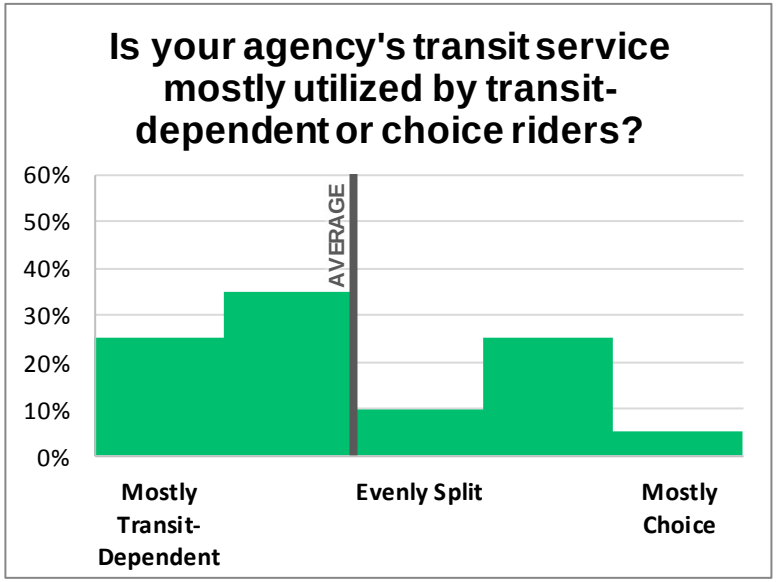


Figure B-1

If you have areas of your community that are not well-suited to traditional transit service, what are the characteristics of these areas?

These areas are sprawling suburban neighborhoods that would fall into the first mile/last mile zone just beyond the transit routes. Individuals who reside in these neighborhoods have expressed interest in using transit, but the number of riders generated from adding a route into the neighborhood for individuals to use would not justify the cost of service.

Slightly outside the ¾-mile area

Exurban with low residential densities and narrow, rural roads not well suited to traditional transit buses. Suburban communities characterized by cul-de-sac's and limited through streets.

Areas that are not as close to main transit corridors. They do not have enough density to have as frequent service.

Low density, single family homes not meeting current service standards for ridership productivity

Narrow streets, low density, low clearance overpasses, and dead ends with poor turnarounds

It's difficult to accommodate riders in the more remote parts of our service area. For example, one rider that is 15 miles outside of a more populated area is harder to fit into a schedule. Also, there are riders that have driveways a bus can't travel on due to low hanging trees or the road is just in really bad shape.

Very rural, highly dispersed population and destinations

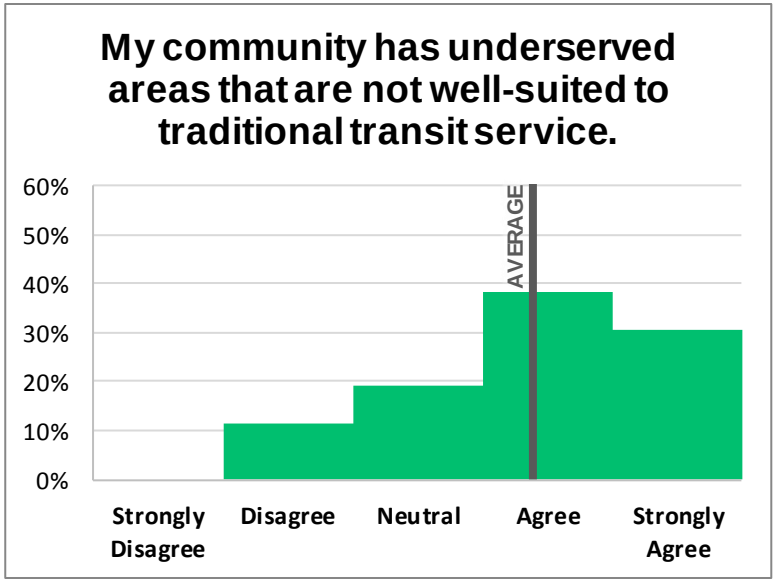


Figure B-2

Very low population density

More ex-urban areas without local bus or Metro service.

Rural/low density areas

Low population density

Exurban/rural roadway configurations

Activity centers far apart

Large percentage of out-commuters

Distinct geographic divides between residential and commercial development

Lower density; suburban

Suburban, cul-de-sac communities, no curb or gutter or sidewalks, low density- single family housing

More remote, rural areas

Congestion of small streets. This will not allow for fixed route or door to door service.

Less dense population; single-family dwellings; rural areas

Rural areas in the county

Low-density, physical distance from the core of the service area/city

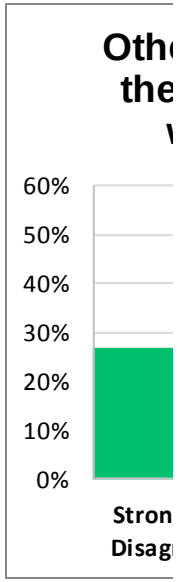


Figure B-3

Figure B-4

If your agency is involved in shared mobility efforts, please describe.

We are in the middle of analyzing paratransit service mobility options as well as how to get passengers to targeted destinations in a timely and efficient manner using augmented services

We are about to embark on an alternative transit study that will be looking at a range of flexible, alternative transportation systems including autonomous vehicles

We currently have shared mobility efforts for paratransit service.

New Freedom program brokers rides with other human service agencies and private transportation companies. We would be very interested in pursuing other opportunities.

Demand response service to and from Carilion New River Valley

The rural part of the county is supported by on-demand service

TDM, rideshare, Nu-Ride, vanpool, carpool matching services

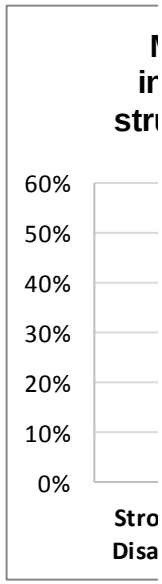
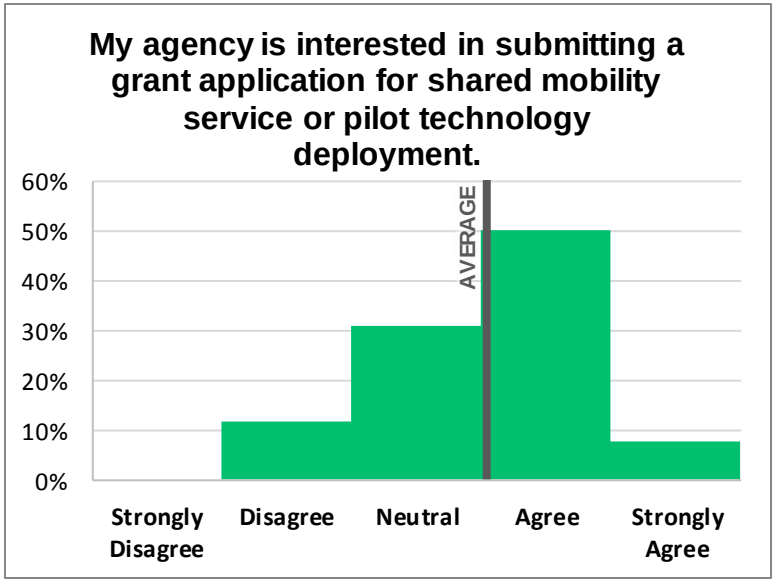
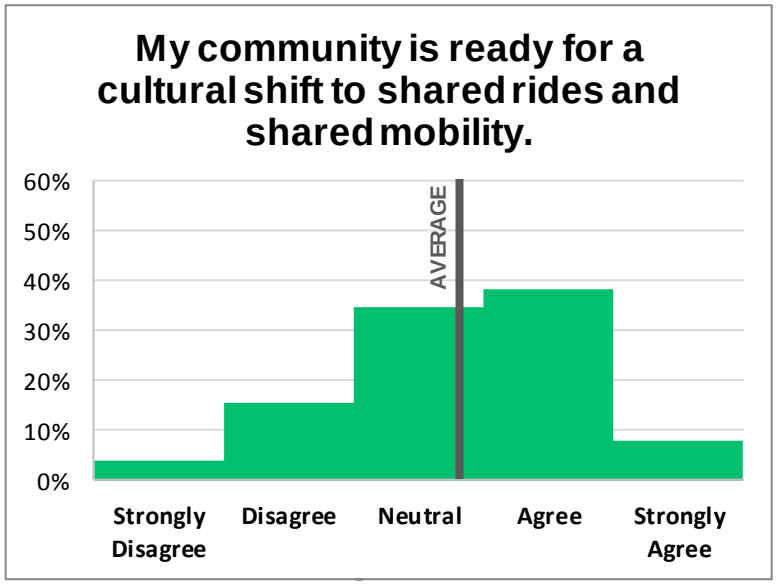
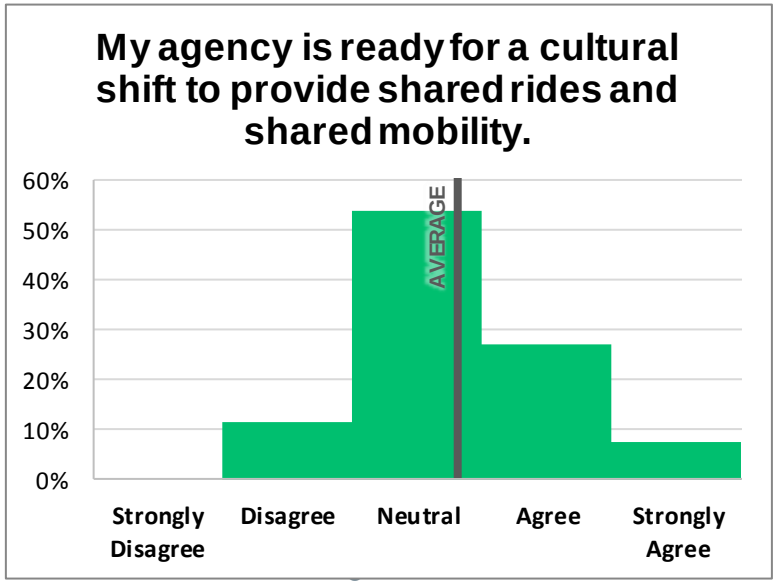


Figure B-5

Figure B-6


My agency is interested in submitting a grant application for shared mobility service or pilot technology deployment.
60%
50%
40%
30%
20%
10%
0%
AVERAGE
Strongly Disagree
Disagree
Neutral
Agree
Strongly Agree


My community is ready for a cultural shift to shared rides and shared mobility.
60%
50%
40%
30%
20%
10%
0%
AVERAGE
Strongly Disagree
Disagree
Neutral
Agree
Strongly Agree


My agency is ready for a cultural shift to provide shared rides and shared mobility.
60%
50%
40%
30%
20%
10%
0%
AVERAGE
Strongly Disagree
Disagree
Neutral
Agree
Strongly Agree

SHARED MOBILITY AND THE FUTURE OF TRANSIT

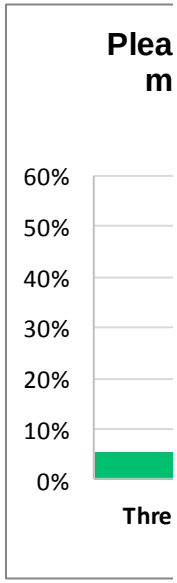
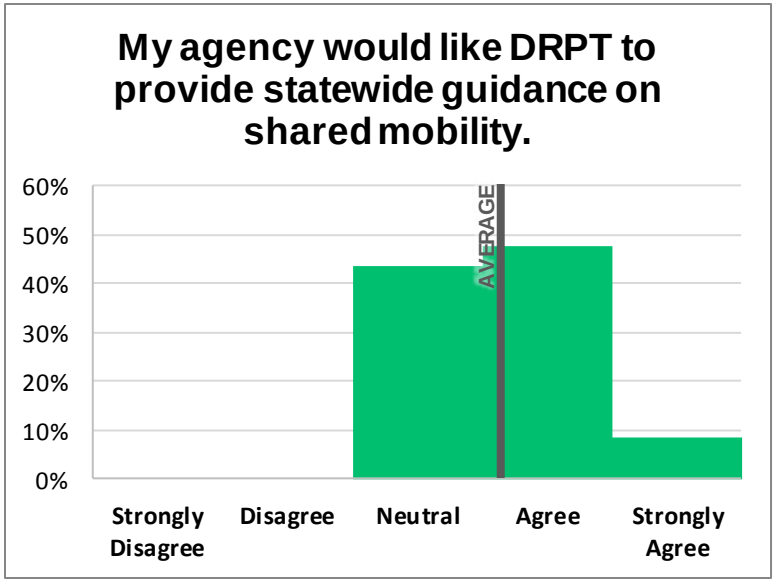


Figure B-9

Figure B-10


My agency would like DRPT to provide statewide guidance on shared mobility.
60%
50%
40%
30%
20%
10%
0%
AVERAGE
Strongly Disagree
Disagree
Neutral
Agree
Strongly Agree

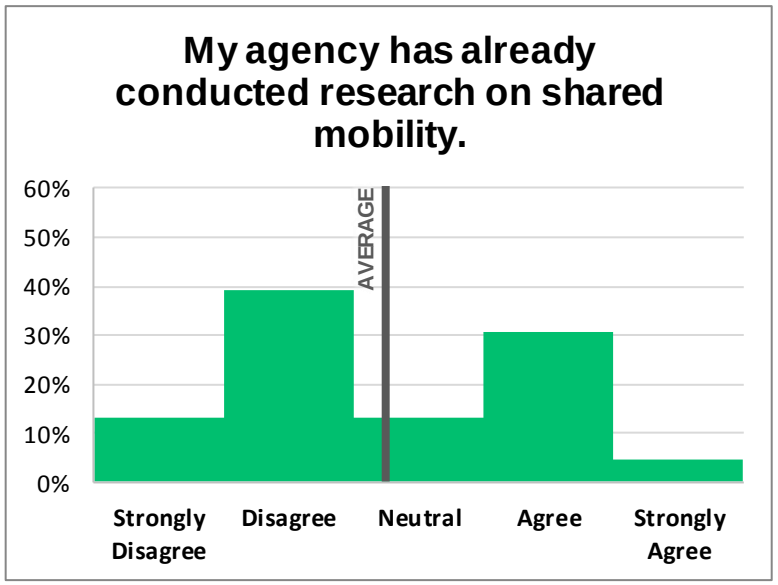


Figure B-11

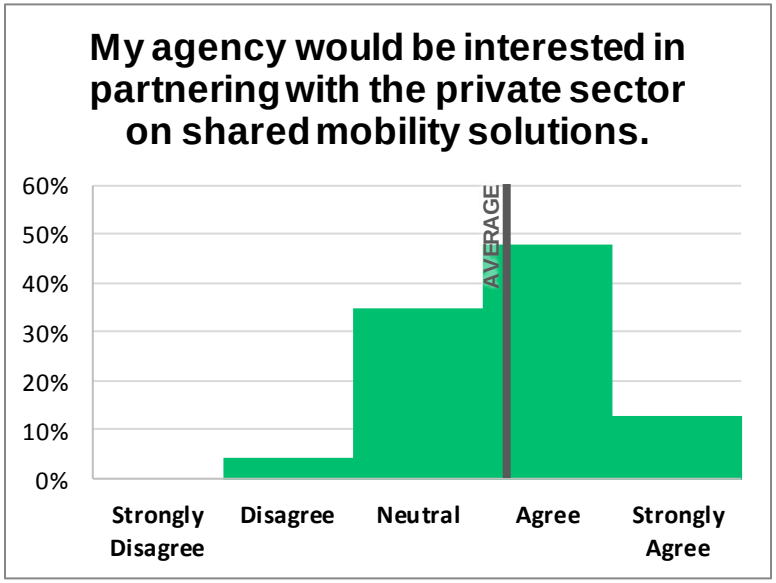


Figure B-12

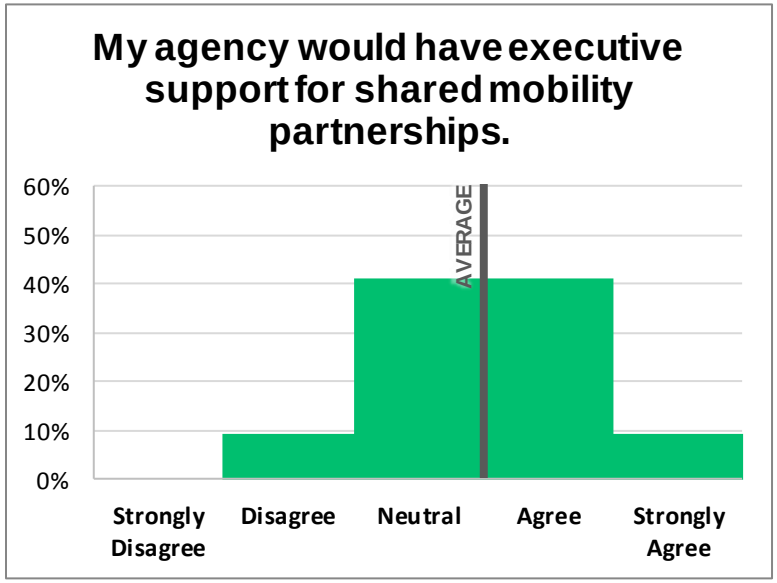


Figure B-13

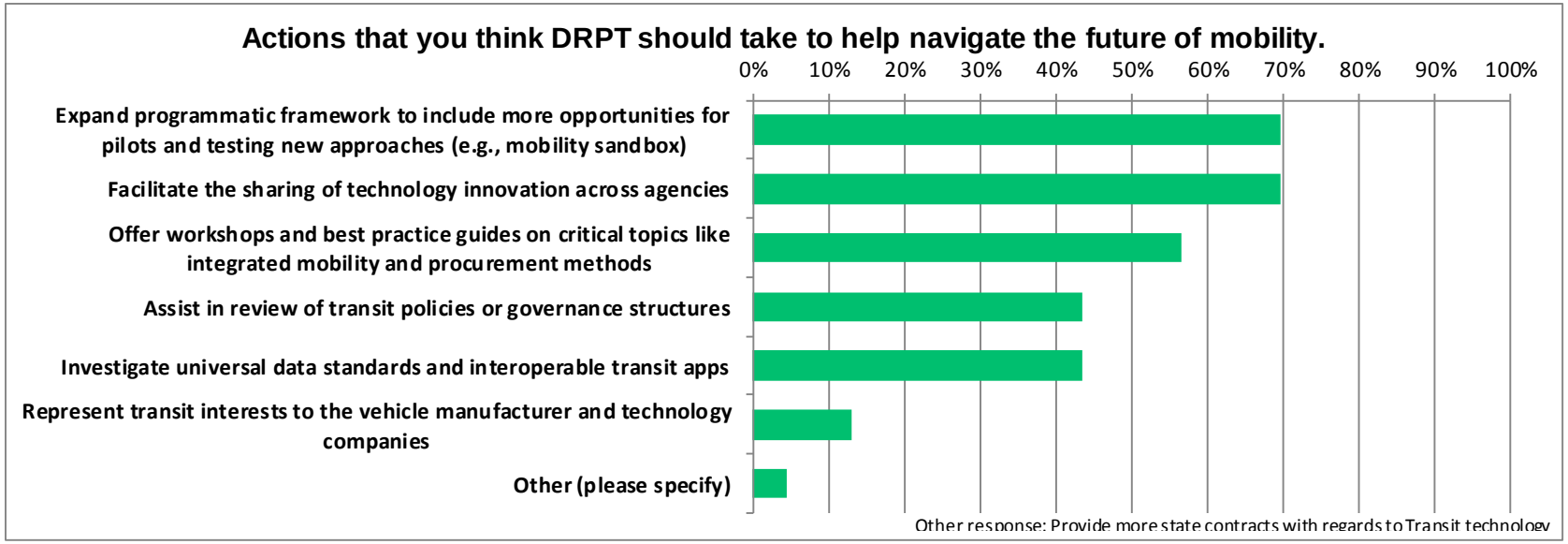


Figure B-14

What are shared mobility projects or places have you seen and would like to know more about?

Microtransit and mid-day on-demand services

The microtransit market, and autonomous vehicles

OCTA [Orange County, CA] has microtransit project; BART [San Francisco Bay Area] has a mobility project in the works; RTD [Denver] has mobility as a service RFI out

Waymo autonomous ride sharing pilot in Arizona; MDOT microtransit project in Maryland; VIA ride share app - NYC, Chicago, Washington D.C.

Sacramento, CA [Microtransit pilot service]

GRTC's partnership with Roundtrip

Several efforts in Florida

Teaming up with MPO on a research project looking at shared use mobility as a flex service concept.

Private transportation agencies which partner with public transit agencies in order to provide fixed route related paratransit.

I would like to know more about one-call centers, using TNC's for mobility.

A one-call-center

Single app scheduling and fare payment for Transit/TNC/Bikeshare

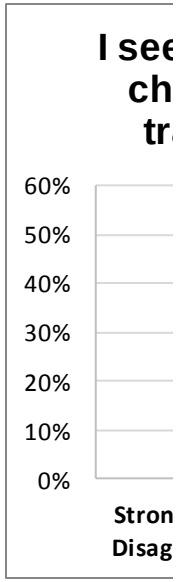


Figure B-15

Figure B-16

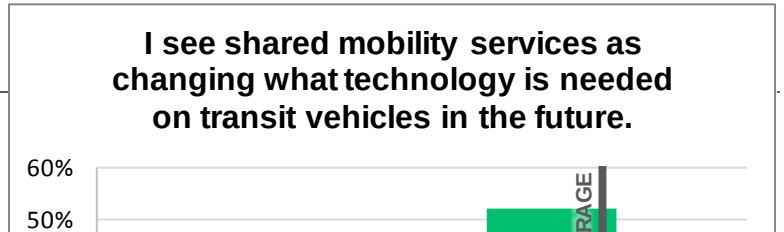


Figure B-17

Figure B-18

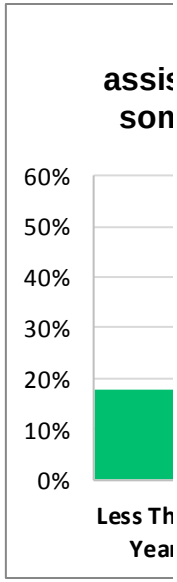


Figure B-19

Figure B-20

If you see shared mobility services changing the future way transit is provided, please describe

I see there being an increased demand for prompt pick-ups and more direct service. Following a schedule and fixed bus line is less enticing to the new generation who have become accustom to instant gratification and not having to wait for results.

Technology funding mechanisms would need to improve; vehicle types would vary and probably utilize smaller fleet classes; operations responsiveness would be more on-demand; operator safe guards and protections would need to be reviewed - their duties would not diminish

How service is procured by the agency, how liability is handled, how this service will be integrated with other established transit services in terms of transfers and fare medium compatibility.

There would be more reliance on apps, more real time monitoring remotely, and additional vehicle types

Only see changes in first and last mile

Transit planning would move more toward a frequency and ridership building model and away from a coverage, low frequency model

Expansion of technology, operational duties could be expanded to provide riders information about their transit needs.

Mobile ticketing to span across all public and private mobility systems to allow for one ticket and easy transfers

More opportunities

Most transit service will be on-demand and individualized.

I see transit becoming much more technologically dependent. Riders want to know where their ride is and if there are seats available. Many of them would like publicly provided Wi-Fi.

Autonomous vehicles are the big thing. Inside activity centers and dense urban areas they'll likely fit well as a shared mode. Not enough research has shown up regarding the behavioral aspects of suburban residents adopting autonomous shared-ride travel solutions. TNC use cases in suburban/rural areas probably have some lessons on this.

Refocusing transit service on routes with higher density and ridership while other mobility solutions are utilized in lower density and ridership areas

Prioritize statewide funding for investment in technology that would support shared mobility operations. Operator duties may not require CDL's in the future.

Change in technology to facilitate shared mobility in the transit industry.

I believe the technology would have to change. There should be more efficient software in scheduling of pick-ups and drop-offs. There should not be a wait time no longer than 10 minutes after appointment is scheduled for pick-up, especially if a one-call-center is involved.

Allowing more of the community to access our services, "extending" the routes into more areas of my community without full sized buses.

ITS, DATA, AND BUSINESS INTELLIGENCE

If you are aware of recent ridership trends or the underlying cause of the trend, please describe.

I am aware of ridership trends but cannot determine the underlying cause.

Ridership trend = declining; underlying causes are varied in our region and are what we are researching

Out transit system is oriented to feeding trips to Metrorail. Maintenance surge related impacts to rail ridership have also impacted bus ridership. Evolving travel patterns are changing where and when people are traveling. There is a disconnect between where and when transit goes and where and when people are traveling.

Recent ridership trends at our agency and around the country are trending down. We have experienced a decrease in ridership over the past 5 years. There other transit options, as well as a decrease in gas prices that have contributed to the trend.

Additional telework, changes in regional travel patterns, decrease in service reliability by all providers in region

Our ridership has been declining, consistent with national trends for our demographic. A great deal of this is due to our service model not being very convenient - predominantly a coverage, low frequency service

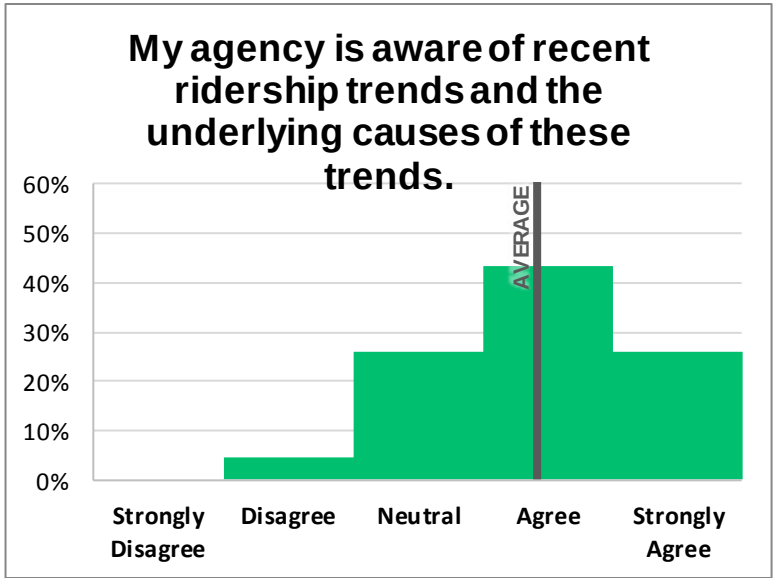


Figure B-21

Ridership is down considerably. Without analyzing the data, I feel there are several reasons contributing to this; attrition, lower gas prices, unemployment, and changes of the needs in the communities without the service changing along with them.

Dependent on enrollment of university students

I am aware that ridership is declining but am not sure exactly what, if anything, can be done about it.

General drop in ridership lasting several years. No single reason, but generally our services don't match with the needs and expectations of our community as well as they did a few years ago. A true strategic planning effort every decade or so can help with this.

Bus ridership is trending downward on most systems in NOVA; likely causes are more teleworking, more options through TNCs, carpool/vanpool, bike and scooter companies, Express Lanes allowing SOV usage for a toll, etc. Likely a permanent downward trend that will require a rethinking of service. We are currently working with local NOVA transit providers on a sweeping Bus Transformation Study that could lead to major changes in how bus service is delivered in the Washington, DC region.

Steady downward trend in local bus ridership for the past four years. Ranging from 3% to 7% decreases annually. Light rail and ferry ridership holding steady, or nominally increasing.

More parking decks and additional road capacity factor into our recent ridership trends.

Lower fuel costs have negatively impacted ridership - returning people to SOV's for their commute.

Lower community college enrollment has negatively impacted ridership.

Para-Transit can travel 3/4 of a mile within the fixed route service. Our service lost a locality due to the locality not able to provide a local match to fund the service. This took away about 30% of the Para-Transit service to that locality.

We are seeing increased ridership due to continued growth of institutions and housing in our service area. Reliable, consistent service and timely data served to riders has allowed us to continue to grow ridership and efficiency of service delivery.

The recent downward trend of transit ridership can be attributed to gas prices, car ownership is cheaper, the introduction of mopeds/scooters, and Uber/Lyft services. Environmental issues such as unemployment, lack of healthcare, or a decrease in reasons to travel in general.

We track ridership and transit usage to determine the overall ridership, usage of stops, and in factoring improvements to facilities.

Describe any efforts your agency conducts to actively use data to assess service and make adjustments (schedules, routes, etc.) to meet changes in demand.

This is not something that has been done in the past. I would like to do this in the future but need to build the infrastructure to do so.

Analysis of routes is continuous. We heavily use KPIs to do analysis of how our service is performing and then work to understand impacts and actively make changes. Origin and destination information is compiled and upgrading of systems to add real-time information are in progress.

Performance data generated from our CAD/AVL system is supplemented with information provided by bus operators, supervisors and the riding public to address issues with service. Our agency will also be undertaking an on-board survey to gain insights on when and where riders are traveling. Our agency has also used other tools including on-line surveys to gain insight into the travel behavior and needs of the general population, not just current transit riders.

We have categorized all of our routes to determine whether a route passes, needs to be watched, or fails its performance metric threshold. If a route needs to be watched or failed, specific timepoint and trip data is pulled to identify the weak points of the route and what needs to be changed to improve the overall performance.

Our agency reviews on-time performance; we have undergone consolidation of bus stops to remove low ridership stops.

We continually use data to ensure we are meeting the needs our community

We analyze data monthly and present this data to our Council and BOS. They tend not to view this data as a means of decision making.

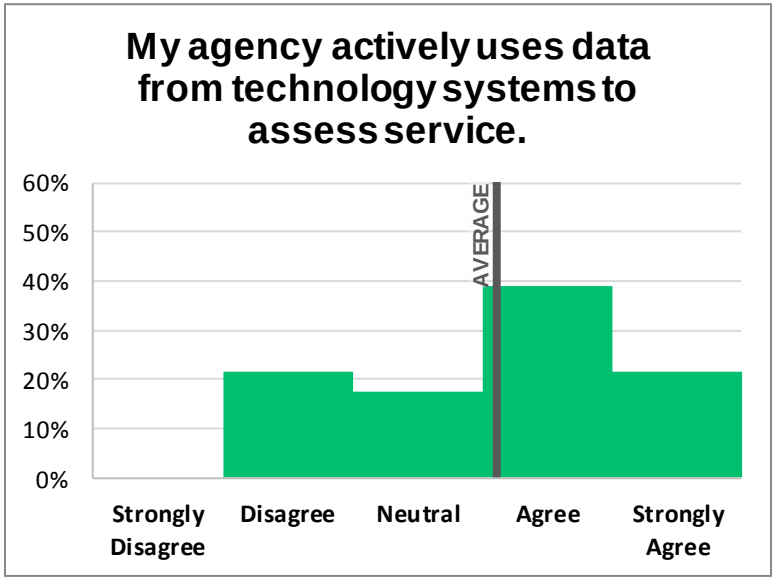


Figure B-22

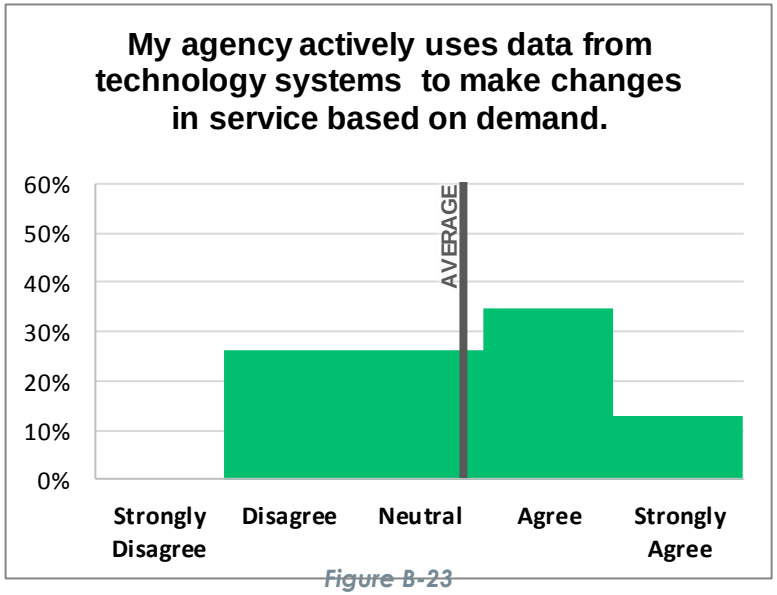


Figure B-23

We tried to introduce fixed route type services with demand response acting as a feeder service to enable riders in the more remote areas access to retail and health services. These services were underutilized and discontinued. I feel more outreach and marketing may help a bit but staff and finances are a concern.

Our agency just implemented an APC system and will use this in the future after system is functioning properly

We actively use GPS data to assess schedule adherence. We actively use farebox data to determine the viability of routes and stops. We actively use real-time Automated Vehicle Maintenance data to proactively repair buses before they breakdown with customers on board.

Ridership is tracked through electronic farebox reports to identify trips experiencing crowding.

AVL data is routinely reviewed to identify needed scheduling adjustments.

We just prepared a ten- year TDP that calls for major investments in top 20 performing routes with high frequency bus service of at least 15-minute headways. The TDP also calls for large investments in passenger amenities, technology infrastructure such as real-time passenger information and mobile fare payment. A larger expansion of local bus fleet is needed to supply 15-minute service frequencies.

APC counts and manual entry counts from mobile data terminals are used to modify and adjust schedules.

We currently only use the data to assess ridership.

We conduct on/off counts at all stops at least once per year to evaluate stops.

We are aware of planned and new development to assess rider demand for new stops.

Our paratransit software is utilized daily to make schedule adjustments.

We use stop-by-stop and trip data to look for trends for allowing efficient distribution of resources. Currently, we avoid making major changes until the summer or beginning of Full Service in the fall.

We closely examine the running times and dwell time to allow for customers to consistently make connections and for drivers to have time to take breaks.

Describe any business intelligence tools your agency uses for automated reporting, trend analysis, flagging of anomalies, etc.

We are building out internal data warehouse and have formed a data task team to build out KPIs using Tableau, MS SSRS, and SSAS to extract data from databases/flat files/spreadsheets and present data from our internal transit systems (CAD/AVL, revenue, asset management, fuel systems, etc.). BI projects are in the works (ridership at stops, automation of operations requirements, etc.) but we have limited staffing resources and funding.

Clever Reports, CleverCAD, Ridecheck Plus, GFI reports. We use both preformatted reports as well as Excel and ArcGIS analytical tools to do trend analysis and map analysis of key metrics.

We use Clever tools, such as Clever Reports, and RideCheck Plus as automated tools that provide reporting for ease of analysis. We additionally do exports from the systems to develop a tool that also analyzes the data and identifies trends. This is done through Excel or Tableau.

We use our AVL software and APC reports.

We recently installed an automated passenger count system to assist with analyzing data.

We use our fare payment and CAD/AVL software systems.

We use Routematch scheduling software and use those reports.

Our agency uses Passio.

TransTrack management system is used to track operational activity and statistics.

We have Avail and Engraph for schedule adherence.

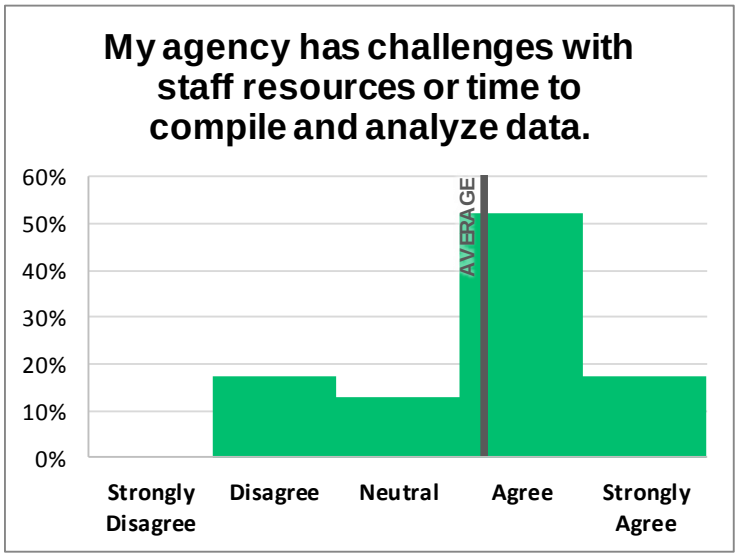


Figure B-24

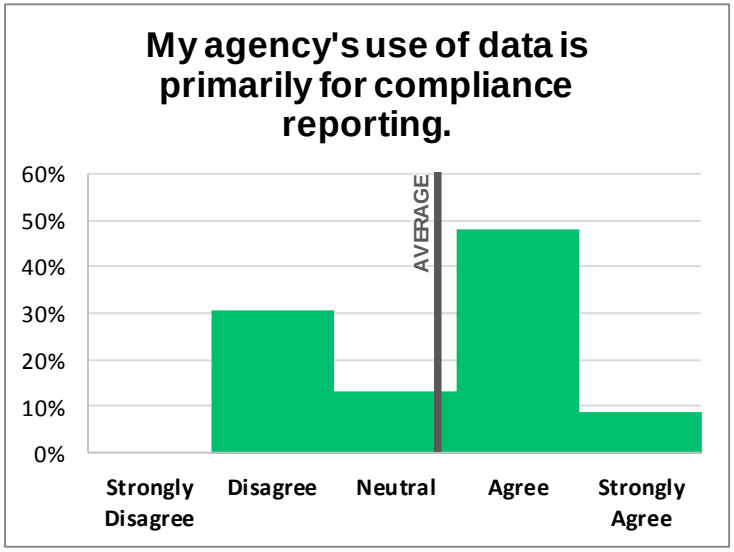


Figure B-25

We currently use CTS Software for para-transit scheduling and, Routematch for fixed-route scheduling, AVL and ridership.

This is done manually at this time.

CTS software system, Route Match software system

We don't use any BI tools at this point; we have a strong reporting structure that allows staff to look for issues and concerns on a weekly or monthly basis.

GFI GDS

Are there technology applications that your agency is interested in learning more about, piloting, or submitting a grant application for? Please describe.

We are currently looking at TBEST with DRPT and feel excited about the forecasting opportunities this will provide. it would be great to pilot projects that help us leverage the technology on the vehicles that we have such as Bluetooth beacon integration with mobile fare collection for wayfinding and next bus notifications maybe revenue sharing with advertising; PPP for communications/fiber like trackside fiber - high speed Wi-Fi for passengers on train, generate income stream potential; ultra-wide band network and onboard communications projects; mixed reality/VR to support maintenance/repairs; we have terabytes of data that can be mined but limited staffing and funding resources to support the efforts

Remix software.

We would be interested in submitting a grant applicator for a more automated business intelligence system, that would pull data from disparate systems to analyze.

Automatic Passenger Counters. We would like to pilot these on our high frequency services

We would love to pilot autonomous vehicles.

Using big data sources (like Streetlight) to understand travel demand would be interesting.

Not at the moment. We just purchased new technology. Maybe within the next five years.

CAD/AVL

Yes. Is there any type of grant out there to start a one-call - center?

Facility parking management, automated fleet assignment, maintenance tracking,

Better customer facing apps and an account-based ticketing/payment system.

Appendix C: Transit Technology Acronym Guide

Technology	Description
CAD/AVL	Computer-aid dispatch/automated vehicle location – vehicle tracking and monitoring relayed to a central system
APC	Automatic passenger counter – devices that automatically count boarding and alighting passengers
AVA	Automated voice annunciator – prerecorded audio and visual announcements triggered by GPS signal
TSP	Transit signal priority – provides transit vehicles with expedited treatment at intersections by communicating with the traffic signal or central system
ERF	Electronic registering farebox – scan and assess the value of fare media presented by boarding passengers and stores information on the transaction
MDT	Mobile data terminals/tablets – on-board devices for operator data input/text communication often with real-time location capabilities
Cameras	Video monitoring or recording of activity on-board transit vehicles
ADAS	Advanced driver assistance system – on-board systems to help the operator in the driving process including sensors, collision warning, blind spot detection, or low levels of automation
GTFS	General Transit Feed Specification – public data feed of static transit schedule
GTFS-RT	General Transit Feed Specification Real Time – public data feed of real-time transit operations such as delays, alerts, or vehicle positions
RT Web	Real-time information provided to customers via the internet
RT Mobile	Real-time information provided to customers via mobile apps or mobile web site
Trip Planner	Interactive service provided via internet, mobile device, or kiosk for identifying best travel route
IVR/SMS	Interactive voice response system or short message service for providing traveler information via telephone or text message
Mobile Ticketing	System that allows customers to purchase and validate tickets or fare via their smartphone
Scheduling Software	Software for trip building, run cutting, vehicle assignments, operator assignment, etc.
Data Analytics/BI	Data analytics/business intelligence software tools for maintaining, analyzing, and reporting data to improve operations

Technology	Description
Maint Mgmt	Maintenance management software for tracking vehicle health, maintenance inspections, and repairs
Yard Mgmt	Yard management software for real-time asset location for optimized yard operations
Info Display	Information displays at stops, stations, or activity centers to provide static or real-time information to customers
Security Cameras	Video monitoring or recording of activity at transit facilities (stations, yard, etc.)
Fare Vendors	Ticket machines at stops or station platforms that allow customers to purchase fares or passes off-board the transit vehicle
Shared Mobility	Alternative transit services (shuttles, microtransit, on-demand ride services) or partnerships with other mobility service providers