FTA Report No. 0244

FTA RESEARCH
FEDERAL TRANSIT ADMINISTRATION

Arlington Rideshare, Automation, and Payment Integration Demonstration (RAPID) Final Report

PREPARED BY

City of Arlington
Via Transportation, Inc.
May Mobility
University of Texas at Arlington

U.S. Department of Transportation
Federal Transit Administration

APRIL
2023

COVER PHOTO

Courtesy of City of Arlington, TX

DISCLAIMER

Arlington Rideshare, Automation, and Payment Integration Demonstration (RAPID) Final Report

APRIL 2023

FTA Report No. 0244

PREPARED BY
City of Arlington
101 W. Abram Street
Arlington, TX 76010

Via Transportation, Inc.
10 Crosby Street, Floor 2
New York, NY 10013

May Mobility
650 Avis Drive, #100
Ann Arbor, MI 48108

University of Texas at Arlington
701 S. Nedderman Drive
Arlington, TX 76019

SPONSORED BY
Federal Transit Administration
Office of Research, Demonstration and Innovation
U.S. Department of Transportation
1200 New Jersey Avenue, SE
Washington, DC 20590

AVAILABLE ONLINE
https://www.transit.dot.gov/research-innovation/fta-reports-and-publications

Metric Conversion Table

SYMBOL	WHEN YOU KNOW	MULTIPLY BY	TO FIND	SYMBOL
LENGTH				
in	inches	25.4	millimeters	mm
ft	feet	0.305	meters	m
yd	yards	0.914	meters	m
mi	miles	1.61	kilometers	km
VOLUME				
fl oz	fluid ounces	29.57	milliliters	mL
gal	gallons	3.785	liters	L
ft^3	cubic feet	0.028	cubic meters	m^3
yd^3	cubic yards	0.765	cubic meters	m^3
NOTE: volumes greater than 1000 L shall be shown in m^3				
MASS				
oz	ounces	28.35	grams	g
lb	pounds	0.454	kilograms	kg
T	short tons (2000 lb)	0.907	megagrams (or "metric ton")	Mg (or "t")
TEMPERATURE (exact degrees)				
^oF	Fahrenheit	5 (F-32)/9 or (F-32)/1.8	Celsius	^oC

REPORT DOCUMENTATION PAGE

Form Approved
OMB No. 0704-0188

1. REPORT DATE	2. REPORT TYPE	3. DATES COVERED
April 2023	Annual Report	March 2020–December 2022

4. TITLE AND SUBTITLE
Arlington Rideshare, Automation, and Payment Integration Demonstration (RAPID) Final Report

5a. CONTRACT NUMBER
5b. GRANT NUMBER
5c. PROGRAM ELEMENT NUMBER

6. AUTHOR(S)
Ann Foss

5d. PROGRAM NUMBER
5e. TASK NUMBER
5f. WORK UNIT NUMBER

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESSE(ES)
City of Arlington
101 W. Abram Street
Arlington, TX 76010

8. PERFORMING ORGANIZATION REPORT NUMBER
FTA Report No. 0244

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)
U.S. Department of Transportation
Federal Transit Administration
Office of Research, Demonstration and Innovation
1200 New Jersey Avenue, SE, Washington, DC 20590

10. SPONSOR/MONITOR'S ACRONYM(S)
FTA

11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12 . DISTRIBUTION/AVAILABILITY STATEMENT
Available from: National Technical Information Service (NTIS), Springfield, VA 22161; (703) 605-6000, Fax (703) 605-6900, email [orders@ntis.gov]; Distribution Code TRI-30

13. SUPPLEMENTARY NOTES [www.transit.dot.gov/research-innovation/fta-reports-and-publications] [https://www.transit.dot.gov/about/research-innovation] [https://doi.org/10.21949/1527657] Suggested citation: Federal Transit Administration. Arlington Rideshare, Automation, and Payment Integration Demonstration (RAPID) Final Report. Washington, D.C.: United States Department of Transportation, 2023. https://doi.org/10.21949/1527657.

14. ABSTRACT

The Arlington Rideshare, Automation, and Payment Integration Demonstration (RAPID) project is an integration of a shared, dynamically-routed automated vehicle (AV) fleet into an existing public rideshare system in Arlington, Texas. The City of Arlington, working with Via Transportation, Inc., May Mobility, Inc., and the University of Texas at Arlington (UTA), led the demonstration from March 23, 2021, to March 18, 2022, in a one-square mile area that included Arlington's downtown and the UTA campus. Over the one-year RAPID demonstration, a total of 28,140 rides were provided with no safety incidents or accidents, successfully demonstrating that an AV service could be seamlessly integrated into an existing on-demand rideshare service and that the public would accept automated rides. Rider feedback showed that riders felt safe, enjoyed the service, and appreciated the free fares for UTA students. Autonomy performance improved over the course of the year as the project team and AV technology learned and adapted to the demonstration area. Findings from the RAPID project can be used to improve automated, shared public transit services in other locations, particularly concerning safety, technology, design of service parameters, communication, and public perception. Data from operational elements and from surveys, interviews, and focus groups provide helpful analysis, conclusions, and recommendations that can be used by others seeking to deploy similar services. The City of Arlington and its partners will continue to operate the RAPID service, incorporating lessons learned to improve and grow the service and its benefits to the community.

15. SUBJECT TERMS
Autonomous vehicles, automated vehicles, AV, microtransit, rideshare, mobility-on-demand, MOD, persons with disabilities, AV perceptions and attitudes, travel behavior

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT Unclassified	b. ABSTRACT Unclassified	c. THIS PAGE Unclassified	Unlimited	74	19b. TELEPHONE NUMBER

Standard Form 298 (Rev. 8/98)
Prescribed by ANSI Std. Z39.18

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

Acknowledgments

The authors would like to thank the members of the RAPID Project Team who participated in the project and contributed to the development of this report:

Alicia Winkelblech
Director of Transportation, City of Arlington

Ann Foss
Transportation Planning and Programming Manager, City of Arlington

George Brighten
General Manager, Via

Meghan Grela
Autonomous Mobility Lead, Via

Rob Carter
Customer Operations Manager, May Mobility

Nick Leone
Customer Success Manager, May Mobility

Greg Hladik
Executive Director of Auxiliary Services, University of Texas at Arlington

Sharareh Kermanshachi
Associate Professor of Civil Engineering, University of Texas at Arlington

Abstract

The Arlington Rideshare, Automation, and Payment Integration Demonstration (RAPID) project is an integration of a shared, dynamically routed automated vehicle (AV) fleet into an existing public rideshare system in Arlington, Texas. The City of Arlington, working with Via Transportation, Inc., May Mobility, Inc., and the University of Texas at Arlington (UTA), led the demonstration from March 23, 2021, to March 18, 2022, in a one-square-mile area that included Arlington's downtown and the UTA campus. Over the one-year RAPID demonstration, a total of 28,140 rides were provided with no safety incidents or accidents, successfully demonstrating that an AV service could be seamlessly integrated into an existing on-demand rideshare service and that the public would accept automated rides. Rider feedback showed that riders felt safe, enjoyed the service, and appreciated the free fares for UTA students. Autonomy performance improved over the course of the year as the project team and AV technology learned and adapted to the demonstration area. Findings from the RAPID project can be used to improve automated, shared public transit services in other locations, particularly concerning safety, technology, design of service parameters, communication, and public perception. Data from operational elements and from surveys, interviews, and focus groups provide helpful analysis, conclusions, and recommendations that can be used by others seeking to deploy similar services. The City of Arlington and its partners will continue to operate the RAPID service, incorporating lessons learned to improve and grow the service and its benefits to the community.

Executive Summary

The Arlington Rideshare, Automation, and Payment Integration Demonstration (RAPID) project is an integration of a shared, dynamically routed automated vehicle (AV) fleet into an existing public rideshare system in Arlington, Texas. The City of Arlington, working with Via Transportation, Inc., May Mobility, Inc., and the University of Texas at Arlington (UTA), led the demonstration from March 23, 2021, to March 18, 2022, in a one-square-mile area that included Arlington's Downtown and the UTA campus.

Background

Arlington, Texas is in the middle of the Dallas-Fort Worth metropolitan region, one of the fastest growing regions in the United States. It is the 50th largest city in the country, with a population of nearly 400,000 residents in an area of 99 square miles. Over the past few decades, Arlington has transitioned from a bedroom community to a core city, with growing transportation needs. In 2017, the City implemented a fully on-demand rideshare service, powered by Via Transportation, Inc. (Via), which uses a fleet of six-passenger vans to provide shared rides anywhere within the city limits. The City also completed two previous AV pilot programs, with the goals of testing AV technology in real world settings and educating residents and staff about AV technology to help encourage acceptance. The City desired to test integration of AV technology in the existing on-demand rideshare service to better serve core areas of the city and underserved populations, which was made possible by the Federal Transit Administration's (FTA) Integrated Mobility Innovation (IMI) award.

Objectives

The City of Arlington and its partners designed this project to provide a blueprint for combining AV and rideshare technologies to develop effective, efficient, safe, and accessible transit networks in a low-density setting where traditional fixed-route transit is impractical. Additionally, the RAPID project was designed to be a flexible and integrated transit system that delivers convenient mobility for all riders. This service aimed to improve road safety, expand transit options for riders with limited mobility, and make Arlington's existing rideshare platform more efficient, as well as benefit students traveling in and around campus and Arlington's downtown through free rides for UTA students. On top of the direct benefits to the Arlington community, this project was expected to generate insights to advance AV and ridesharing practices across the transit industry. Specific RAPID project objectives included:

- Increased access for senior citizens, students, and individuals with disabilities
- Improved equity and accessibility to public transit
- Improved safety and efficiency

- Demonstration of performance, safety, and user acceptance of automation on an existing public transportation system
- Demonstration of integrated ride booking and payment between modes
- Use of public-private partnerships for demonstration, data sharing, and knowledge transfer

Findings and Conclusions

Over the one-year RAPID demonstration, a total of 28,140 rides were provided with no safety incidents or accidents, successfully demonstrating that an AV service could be seamlessly integrated into an existing on-demand rideshare service and that the public would accept automated rides. Rider feedback showed that riders felt safe, enjoyed the service, and appreciated the free fares for UTA students. Autonomy performance improved over the course of the year as the project team and AV technology learned and adapted to the demonstration area. Communication and education to riders and the public was robust, but additional outreach could have strengthened messaging to more members of the public.

Benefits

Findings from the RAPID project can be used to improve automated, shared public transit services in other locations, particularly concerning safety, technology, design of service parameters, communication, and public perception. Data from operational elements and from surveys, interviews, and focus groups provide helpful analysis, conclusions, and recommendations that can be used by others seeking to deploy similar services. The City of Arlington and its partners will continue to operate the RAPID service, incorporating lessons learned to improve and grow the service and its benefits to the community.

Section 1 RAPID Project Introduction

The Arlington Rideshare, Automation, and Payment Integration Demonstration (RAPID) project is an integration of a shared, dynamically routed, Level 4 automated vehicle (AV) fleet into an existing public microtransit system in Arlington, Texas. The City of Arlington, working with Via Transportation, Inc. (Via), May Mobility, Inc., and the University of Texas at Arlington (UTA), led the demonstration from March 23, 2021, to March 18, 2022, in a one-square-mile area that included Arlington's Downtown and the UTA campus. Over the one-year RAPID demonstration, a total of 28,140 rides were provided with no safety incidents or accidents.

This final project report is organized in five main sections, as follows:

- RAPID Project Description: this section provides background and context for the project and describes the demonstration goals, challenges addressed by the project team, and the objectives of the project.
- RAPID Project Evolution: this section provides detailed information about the work done by the project team in preparation for demonstration and during the demonstration itself. The project addressed several key elements during the preparation phase, including defining the service area; route mapping; establishing operational parameters; planning for communications and outreach about the service; and research activities that informed the demonstration. Key elements addressed during the demonstration phase included tracking ridership, autonomy, and integration performance metrics; tracking rider experience metrics; installing software updates; making necessary operational changes; continued communication and education about the service; and research activities to analyze the service itself. This section also discusses the evolution of key challenges during the project, including COVID-19 impacts, rider experience, wheelchair accessible vehicle use, and integration between the partner platforms for the service.
- RAPID Project Evaluation: this section evaluates key RAPID project objectives, including increased access for senior citizens, students, and individuals with disabilities; improved equity and accessibility to public transit; improved safety and efficiency; demonstration of automation on an existing public transportation system; demonstration of integrated ride booking and payment between modes; and the use of public-private partnerships for demonstration, data sharing, and knowledge transfer.
- RAPID Project Conclusions and Recommendations: this section highlights the key lessons learned from the RAPID project, recommendations based on lessons learned, and next steps for the RAPID project and team.

Overall, the RAPID project successfully demonstrated the integration of a fleet of automated, on-demand, shared vehicles with an existing on-demand rideshare public transportation service. The service provided increased access for individuals within the service area, and survey results show that many riders had low income levels and lacked access to a personal vehicle. The RAPID service also provided a consistently safe and efficient service for the full duration of the one-year demonstration, with no safety accidents or collisions and high quality-of-service ratings, including wait times and on-time performance. Automated performance improved over the course of the demonstration, suggesting significant learning and improvement by the automation technology and vehicles. Integration between the Via and May Mobility platforms was also robust, and riders were able to use the Via app to book and pay for rides delivered by the May Mobility AVs. The public-private partnership team worked efficiently to provide and evaluate the service and to share lessons learned widely.

Section 2

RAPID Project Description

Context and Project Overview

Arlington, Texas is in the middle of the Dallas-Fort Worth metropolitan region, one of the fastest growing regions in the United States. It is the 50th largest city in the country, with a population of nearly 400,000 residents in an area of 99 square miles. Over the past few decades, Arlington has transitioned from a bedroom community to a core city, with the growing UTA campus and major employers, such as General Motors and Texas Health Resources, as well as a thriving entertainment district that attracts over 15 million visitors to Arlington each year.

In December 2017, Arlington launched a comprehensive, fully on-demand microtransit service, powered by Via, which uses a fleet of six-passenger vans to provide shared rides anywhere within the city limits. The service operates Monday through Friday from 6:00 a.m. to 9:00 p.m. and Saturday from 9:00 am to 9:00 p.m. Riders without a smartphone can call a local telephone number to book a ride with a customer service agent. Fares range between $3.00 and $5.00, depending on distance traveled, and are paid with a credit or debit card. Prepaid cards are accepted for riders who are not traditionally banked. Via has wheelchair accessible vehicles (WAV) operating on the platform, and riders can request a WAV and door-to-door service, as necessary.

Arlington has also completed two AV pilot programs, which operated in the entertainment district using SAE Level 4 vehicles. Both services were open to the public and free to ride, allowing residents, visitors, and City staff to learn more about AV technology. The first pilot was called Milo and used two EasyMile vehicles on an off-street route connecting remote parking lots to stadium destinations within the entertainment district. The Milo pilot operated from August 2017 to August 2018 as an event service during events at the stadiums. The pilot also operated for public demos and special group tours. The second pilot was a partnership with Drive.ai operating on-street in mixed traffic at speeds up to 35 mph in the entertainment district. From October 2018 to May 2019, the Drive.ai pilot operated a circulator route Monday through Friday from 11:00 a.m. to 4:00 p.m., as well as during some events at the stadium. More information about Arlington's AV program can be found here.

A summary of Arlington's microtransit and AV services is shown in Figure 2-1.

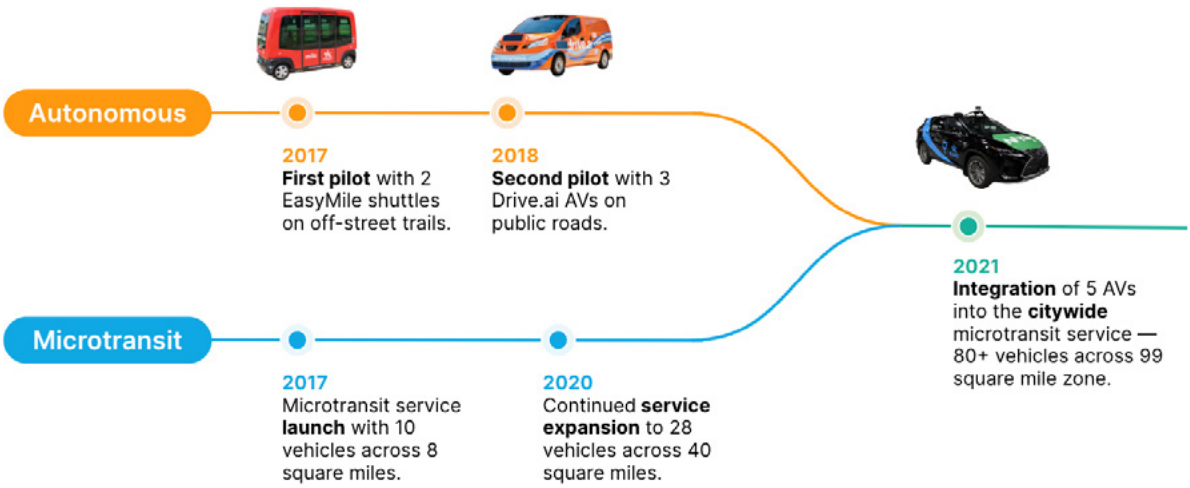

Figure 2-1 *Arlington Microtransit and Automated Services*

The Arlington RAPID project described in this report combines the City's expertise with on-demand shared transit and AV testing to demonstrate the integration of a shared, dynamically routed Level 4 AV fleet into an existing public microtransit system. Through its wholly owned subsidiary, River North Transit LLC, Via continued to provide Arlington's existing microtransit service and May Mobility, Inc., provided the AV technology and fleet for the RAPID project. Both the microtransit fleet and the AV fleet included WAVs, making this service more widely accessible. The RAPID service operated on and around the UTA campus and allowed UTA students to ride for free, and UTA was an active partner on the RAPID project team. This project created a one-stop shop for mobility needs in the service area concentrated around UTA's campus and Arlington's downtown core, providing a seamless trip planning, booking, and payment experience across modes.

The project spanned two and a half years, with the first year dedicated to programming, route mapping, testing, and customer education. The second year included a full 12-month demonstration of the integrated services, along with continued customer education, data sharing and analysis, ridership surveys, and service evaluation. The final six months of the project focused on evaluation, final reporting, and widely sharing lessons learned.

The Arlington RAPID service was deployed from March 23, 2021, to March 18, 2022. The service operated in a one-square-mile area that included Arlington's downtown and the UTA campus (Figure 2-2). Operating hours were Monday through Friday from 7 a.m. to 7 p.m. from launch through early January 2022, at which point the hours shifted to run from 8 a.m. to 8 p.m. to better serve rider demand patterns. A trained AV operator was always in the driver's seat during

the demonstration. The service used a fleet of four Lexus RX450 hybrid vehicles and one Polaris GEM electric, wheelchair accessible vehicle. Booking, payment, and vehicle routing was all performed through the Via service platform. Riders would request a ride on the Via service, and if the parameters of their ride fit the RAPID service, they would be offered both a standard, human-driven Via van and a RAPID automated vehicle. Riders were directed to a convenient pickup location within a one- to two-block walk of their location, creating a personalized and efficient "corner-to-corner" service. Standard Via service fares applied to RAPID rides, although UTA students were able to ride RAPID for free.

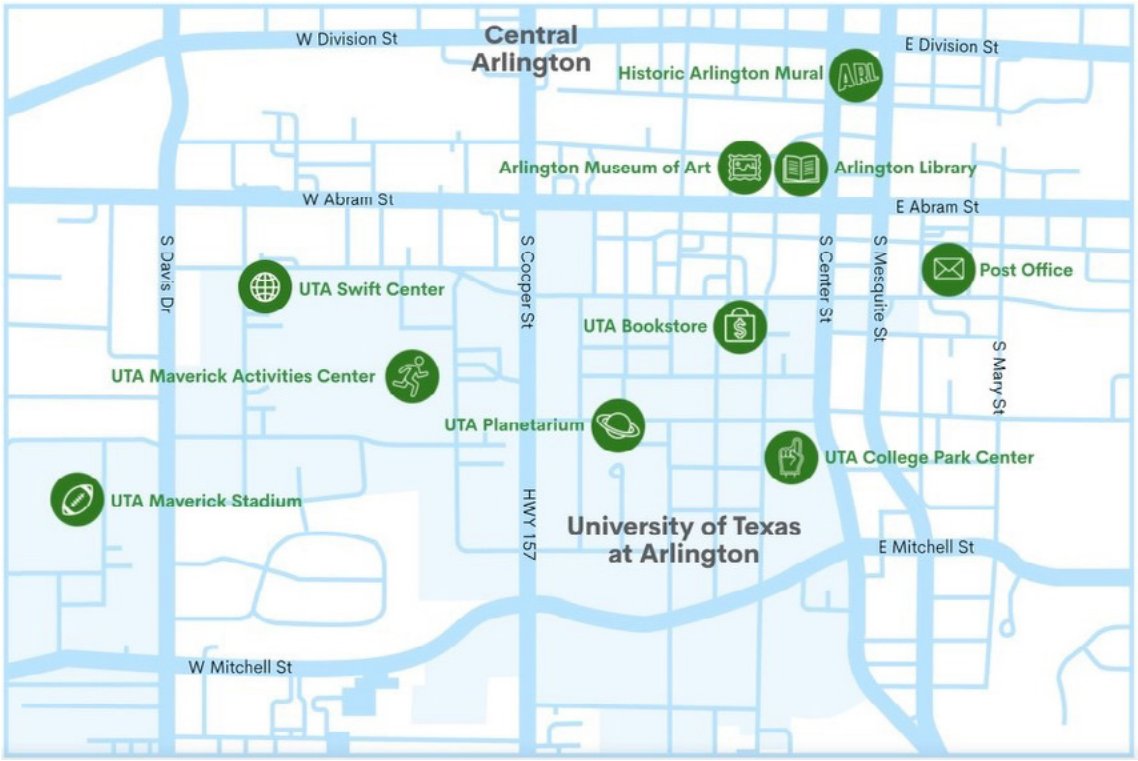

Figure 2-2 *RAPID Service Area*

Over the one-year RAPID demonstration, a total of 28,140 rides were provided with no safety incidents or crashes. Key service performance metrics included an average estimated wait time of 10 to 15 minutes for each ride and average on-time performance of 99 percent.[1] Since riders were always able to choose a RAPID ride or a standard Via ride, acceptance rates were closely tracked. The service started with an average acceptance rate of approximately 75 percent, and this rate rose to over 90 percent during the demonstration year. Autonomy performance was also closely monitored, and average percentage

[1] On-time performance is the percentage of booked trips picked up within the pick-up window and dropped off within the estimated drop-off window.

of time in fully automated mode rose to over 90 percent toward the end of the demonstration. More details about these and other performance metrics are provided in following sections of this report.

Challenges Addressed by the RAPID Project

The Arlington RAPID service was available to the public, and it was also targeted specifically to the UTA community. With over 100 buildings spanning 420 acres, UTA is tasked with transporting students, faculty, and staff across its widely dispersed campus, while accommodating each user's unique needs. In addition to the UTA campus, the service area contained various residential uses and the city's commercial downtown. Home to over 11,800 people, the service zone has a poverty rate of 39 percent, compared to 16 percent city-wide, and 18.8 percent of households have a person with a disability. 11 percent of households lack access to a personal vehicle, almost three times higher than the city-wide average of 4.3 percent of households.

The RAPID service addressed needs in the service area by providing an on-demand service that was flexible to the mobility needs of both students and residents. Additionally, by managing the routing and repositioning for the AVs through Via's platform, the fleet was optimized to ensure that each vehicle was dynamically dispatched to meet real-time demand throughout the service area, in a similar manner as the human-driven rideshare service. The RAPID service was one of the first examples of this type of dynamic routing of AVs within a broader public transit service. The AV fleet also included one WAV to expand accessibility to individuals who use wheelchairs. Finally, the RAPID service launched and operated during the COVID-19 pandemic, which required careful attention to health and safety protocols and adjusting protocols as conditions changed, but the service also provided a safe, flexible, and reliable transportation option for riders during this time.

Project Objectives

The City of Arlington and its partners designed the RAPID project to provide a blueprint for combining AV and microtransit technologies to develop effective, efficient, safe, and accessible transit networks in a low-density setting where traditional fixed-route transit is impractical. Additionally, the RAPID project provides a flexible and integrated transit system that delivers convenient mobility for all riders. This service was designed to improve road safety, expand transit options for riders with limited mobility, and make Arlington's existing rideshare platform more efficient, as well as benefit students traveling in and around campus and Arlington's downtown through free rides for UTA students. In addition to the direct benefits to the Arlington community, this project was expected to generate insights to advance AV and microtransit practices across the transit industry. Specific RAPID project objectives included:

- Increased access for senior citizens, students, and individuals with disabilities
- Improved equity and accessibility to public transit
- Improved safety and efficiency
- Demonstration of performance, safety, and user acceptance of automation on an existing public transportation system
- Demonstration of integrated ride booking and payment between modes
- Use of public-private partnerships for demonstration, data sharing, and knowledge transfer

These objectives are assessed in the Evaluation section of this report.

Section 3

RAPID Project Evolution

The RAPID project underwent several key changes and evolutions as the project team studied, prepared, operated, and refined the service. Discussion of these changes is addressed in the following subsections, focused on evolution in the one-year preparation for demonstration phase and the one-year demonstration phase. This section then concludes with a summary of key challenges addressed and overcome during the project.

Evolution in the Preparation for Demonstration Phase

Key elements addressed during preparation for demonstration phase include:

- Defining the service area and route mapping
- Establishing operational parameters
- Communications and outreach
- Research activities

Service Area and Route Mapping

The general desired service area for RAPID was established during the IMI application stage (Figure 3-1); however, when funds were awarded and the project began, refinement to the service area was necessary. Key factors that contributed to the refinement of the service area include analysis of existing public transportation ridership patterns in and around the service area and analysis of autonomy technology performance. The project team analyzed ridership data from 2019 for Arlington's Via rideshare service, paratransit service, and the UTA campus shuttle service to identify key origin and destination locations and other common travel patterns in the service area. Findings from this analysis supported efforts to provide convenient service on RAPID to key destinations on campus, such as the UTA student center and gym, and to student housing developments both on- and off-campus, as well as downtown Arlington destinations, including the city library.

May Mobility staff began with a high-level, virtual review of the proposed service area to identify drivable streets and desired stop locations, while analyzing the existing built environment for autonomy technology performance. This initial analysis resulted in a proposed network of streets that could be utilized by the RAPID service, as well as areas served. The project team provided comments, including on-the-ground information about city construction projects and UTA operations, to refine the proposed network. The existing transportation data and analysis was also incorporated at this stage, to ensure the route network aligned with rider demand patterns.

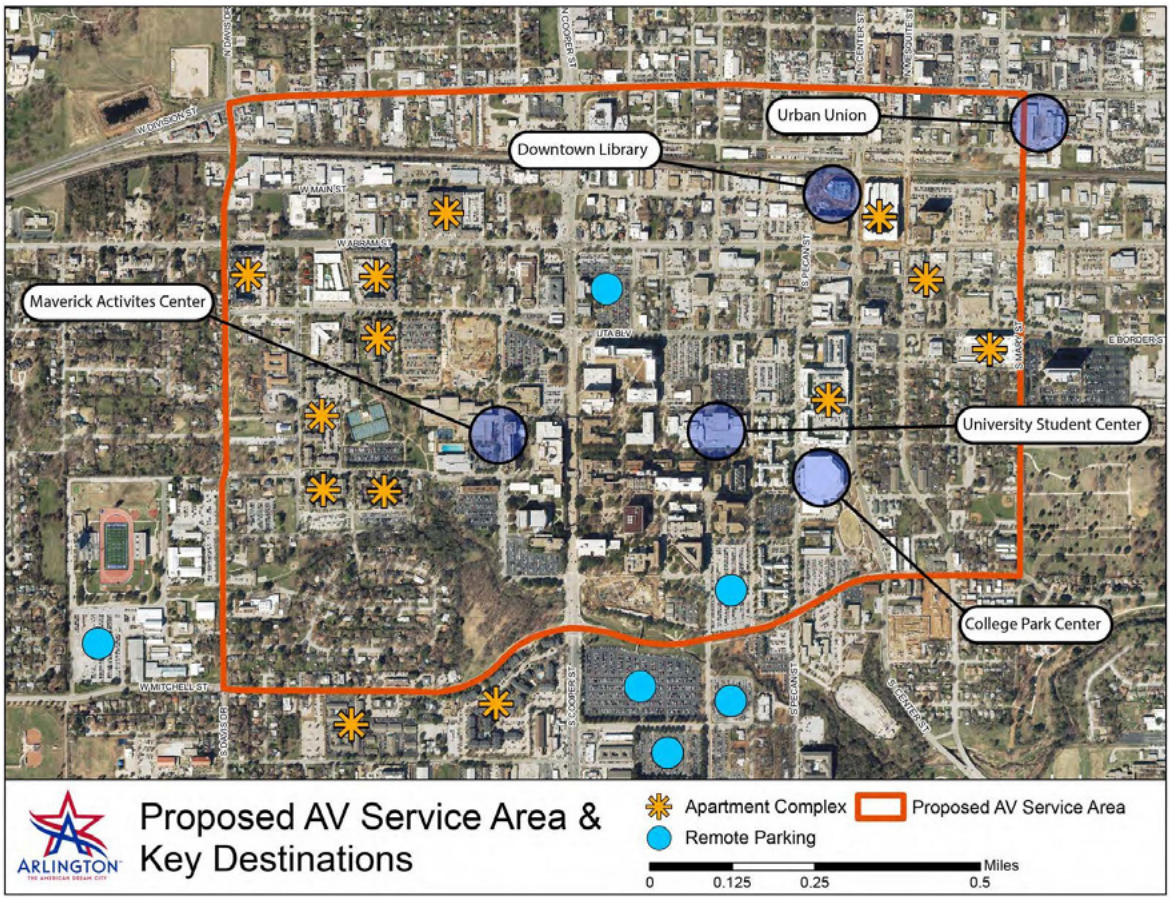

Figure 3-1 *Proposed Service Area from Arlington's IMI Application*

May Mobility staff then traveled to Arlington for in-person review of the proposed route and stop locations. This included reviewing traffic patterns, speed limits, road quality, traffic light positions, construction projects, and pedestrian traffic. Stop locations were evaluated for safety and clear paths for riders to enter and exit the vehicles. A summary of the findings from this visit were discussed with the entire project team to finalize the service area and route network through an iterative process. Some roadways within the service area were unable to be used for the automated route network, due to high speeds, heavy tree cover, or lack of built structures, which can prevent good localization of the vehicles. A route network and stop map is shown in Figure 3-2, which was developed and reviewed extensively by the internal project team. A public-facing service area map was also created and is shown in Figure 3-3. Stop locations for the AV service were not marked or shown publicly, as the project team wanted the service to feel organic and on-demand for riders, like the broader Via rideshare service. Over 35 stops were programmed in the one-square-mile service area, so no matter where a rider booked, there would be a stop location within a short walk.

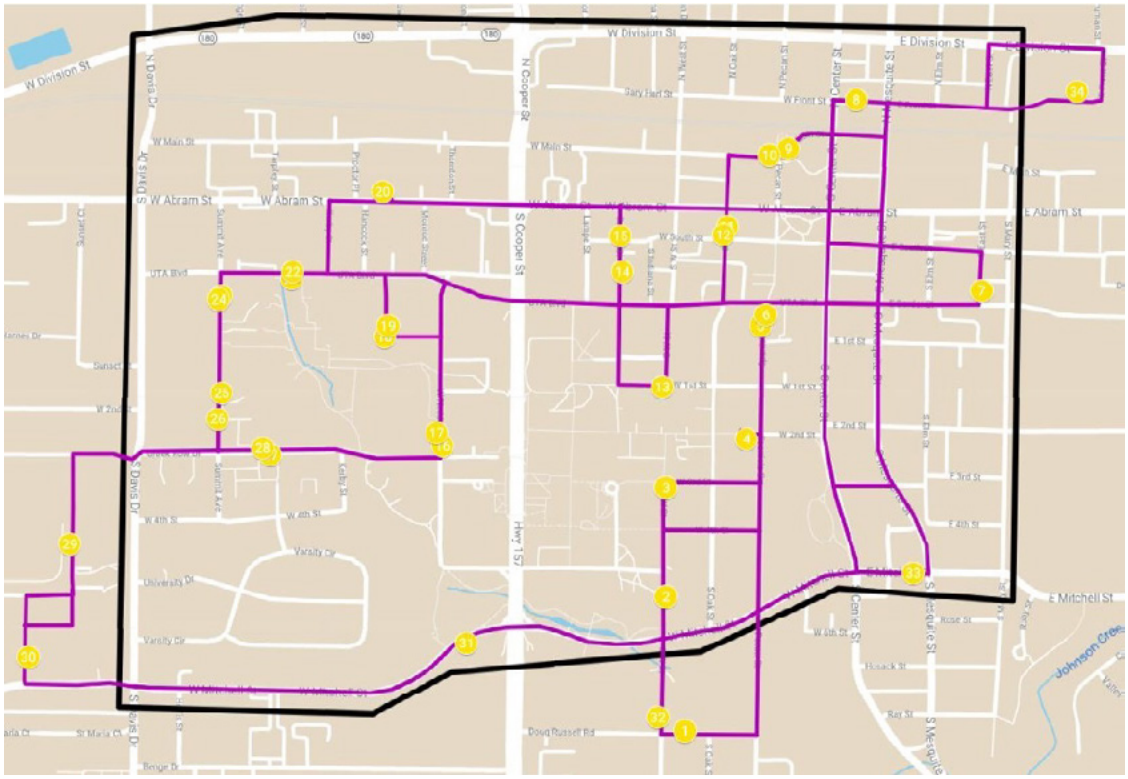

Figure 3-2 *Internal Route Network and Stop Map*

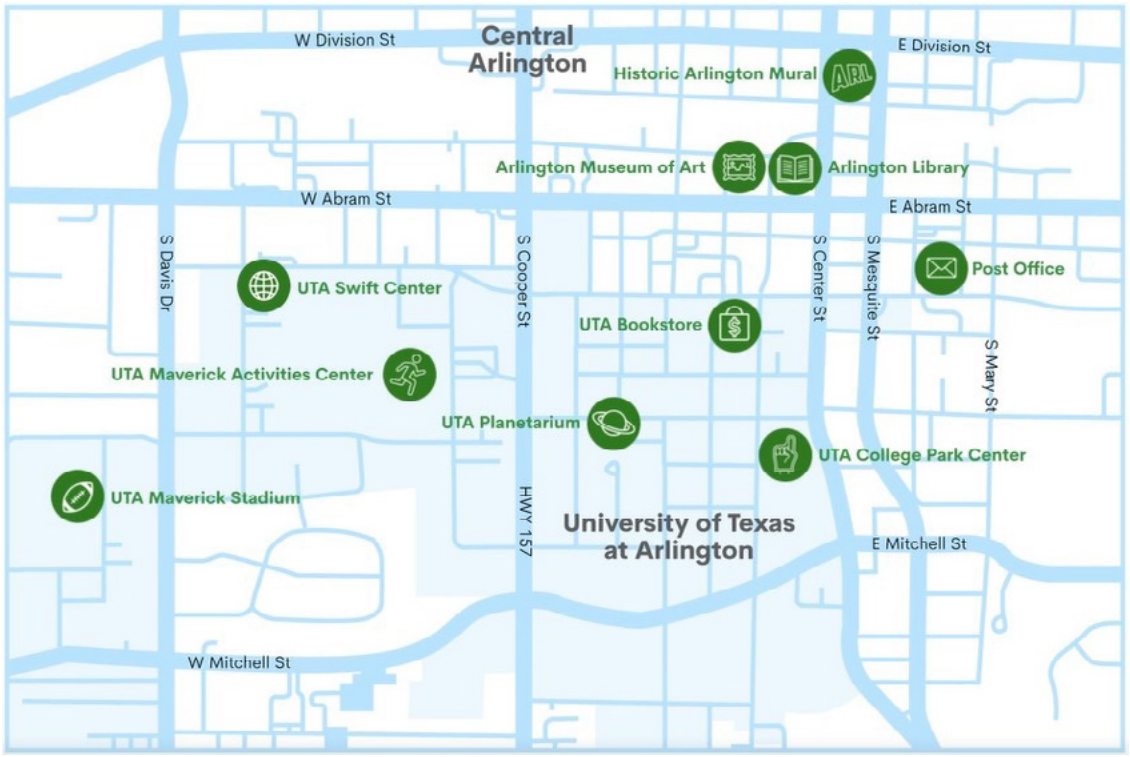

Figure 3-3 *Public-Facing RAPID Service Area Map*

In summer 2020, the team transported a Polaris GEM automated vehicle to Arlington for map data collection, which was used to build the service's localization map. The route network for RAPID was the largest route built by May Mobility to date and additional time was required for the creation of the localization map and route testing. Once the localization map was created based on data gathered by the AV sensors on-site, the May Mobility team refined it, which included adding the locations of lane markings, crosswalks, traffic lights, stop locations, and drive edges into a semantic map that the vehicle uses to navigate the service area. In November 2020 and December 2020, a Polaris GEM automated vehicle and May Mobility team again traveled to Arlington to test the refined localization map. This work involved verifying the localization map and adjusting the locations of drive lanes, paint lines, crosswalks, and traffic lights in the service area.

In January 2021, the Lexus RX450 hybrid fleet vehicles for the RAPID service began arriving in Arlington. This service was the first for May Mobility using an auto-grade vehicle platform, which refers to a vehicle manufactured by an original equipment manufacturer (OEM) for regular road use and driving conditions. It was the first service for May Mobility that moved away from a small, low-speed vehicle (the Polaris GEM e6 shuttle) to a conventional vehicle (the Lexus RX450h SUV). Due to this change, additional testing was required to adjust the route for the new vehicle platform. Extensive autonomy tuning was performed, which included adjusting stop approach speed profiles, adjusting stop locations, and refining steering parameters to ensure a comfortable ride for passengers on the vehicles. As the Lexus SUV did not have the space or configurability to accommodate passengers using wheelchairs, a Polaris GEM WAV was added to the RAPID fleet. After the conclusion of the first year of the RAPID demonstration, a shift was made to a new vehicle that could accommodate both wheelchair and non-wheelchair passengers, a Toyota Sienna. This will be discussed in greater detail below. The Polaris GEM WAV was delivered to Arlington and tested during this period. Final testing and adjustments, including for new construction on the route, were completed in March 2021, in advance of service launch.

Operational Parameters

There were several operational elements that the RAPID project team needed to define and establish prior to demonstration of the service, including service hours, fare structure, payment integration to allow UTA students to ride RAPID for free, COVID-19 health and safety protocols, and an internal incident reporting plan. Additionally, work went into successfully completing integration between the Via and May Mobility technology platforms, to allow for seamless ride booking, payment, and ride dispatch between the two systems.

Using data from existing transportation services, the project team identified key periods of peak demand for travel in the service area. Operational needs from

the May Mobility team were also considered, including the shift duration for safety drivers, called autonomous vehicle operators (AVOs) and the need for the vehicles to go out of service to charge and download data. Using these inputs, the team established Monday to Friday, 7 a.m. to 7 p.m. as the RAPID service hours.

In keeping with the integration of the AV service into the city's existing Via rideshare service, it had been established that the fare structure on RAPID would match that on Via rideshare. Fares range from $3.00 to $5.00, depending on distance traveled, although due to the size of the RAPID service area, most fares on RAPID would be $3.00. Via and UTA also worked closely to determine the best method for creating free rides on RAPID for current UTA students. While several methods were discussed, it was determined that the most effective method was through email domain verification. UTA students would use their active student email account to book rides, and Via configured its platform to recognize this unique email domain and apply free fares for RAPID rides only. UTA students would still be charged the standard fare for non-RAPID rides on the Via service.

With plans to launch the RAPID service during the COVID-19 pandemic, health and safety concerns were top-of-mind for the entire project team. For consistency with the existing Via rideshare service in Arlington, RAPID vehicles were outfitted with partitions between the AVO and rider space in the vehicle, daily vehicle cleaning was performed, and all AVOs and riders were required to wear masks, per Federal Transit Administration (FTA) regulations for public transit. The RAPID vehicles were also outfitted with UV-C lights[2] to regularly disinfect the interior of the vehicle. At the time of launch, the UV-C lights were deployed between each ride (after dropping off a rider and before picking up the next rider). The vehicle capacity was also limited to only one booking at a time, to prevent close contact between unrelated groups of passengers. These measures decreased the service's capacity, due to lack of shared rides and disinfecting time between each ride, but these measures were deemed prudent at the time of launch. After launch, as vaccination rates increased and COVID-19 infection rates decreased in the region, the COVID-19 protocol was modified in July 2021 to remove the vehicle partitions, use the UV-C light to disinfect during vehicle shift changes rather than between every ride, and allow shared rides with up to two bookings at a time. These changes increased service capacity in line with increased demand, as discussed in the following section of this report. The UTA campus operated in a largely virtual format for the 2020-2021 academic year, with face-to-face enrollment at approximately 25-30 percent of traditional on-campus enrollment in spring 2021. It was anticipated that this might negatively affect ridership demand for the first several months of RAPID service, but the expectation of a return to traditional campus operations for the fall 2021 semester was expected to positively affect ridership.

[2] The UV-C devices use light to break down chemical compounds in bacteria and viruses, including the coronavirus, which prevents them from multiplying.

Another key operational consideration was planning for any incidents that might occur with the RAPID service. The project team established a clear process for responding to any incidents, fully investigating the incident, and notification and reporting to involved parties. This process is shown in Figure 3-4. While the service did not experience any collisions, injuries, or safety accidents, there were several minor curb rub events where an AV did not perform as expected. These minor incidents, which are discussed in greater detail in the following section of this report, followed the incident process for clear communication and investigation to resolve and prevent future similar incidents.

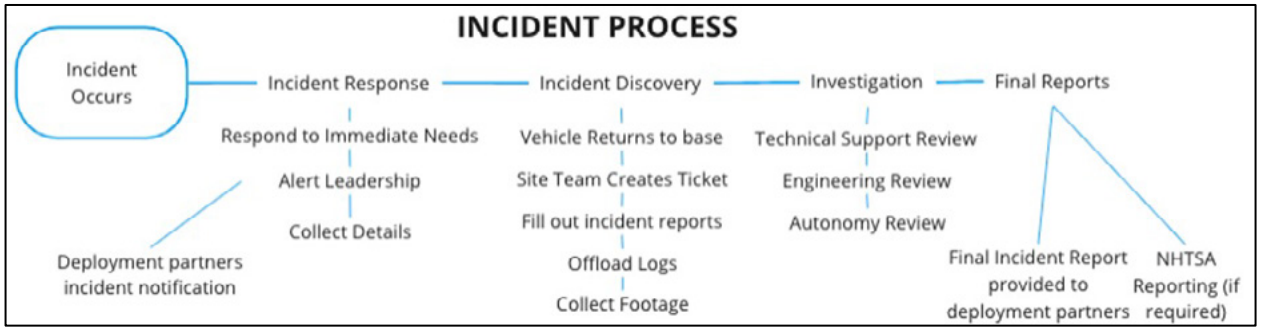

Figure 3-4 *RAPID Incident Process*

The final major operational element involved application programming interface (API) integration between the Via and May Mobility platforms, as well as testing of this integration in various settings, from a sandbox environment to the actual route network. The API integration work began with defining communication needs between the two platforms for riders, AVOs, the May Mobility base station, and vehicle routing. Initial API connections were tested starting in October 2020 to validate API connectivity and responsiveness using an internal on-demand service demonstration route. By November 2020, successful backend integration for all primary use scenarios was completed, including scenarios such as linked rides, pooled rides, and ride cancellations. The following month, Via used the latest information from May Mobility to update its AV route network and stop location map. This allowed for additional extended-use scenario testing. The full route integration was implemented, and a successful on-vehicle field test was performed in December 2020.

With this initial integration and testing complete, the team was able to move into extensive API testing at its headquarters location in January 2021 using May Mobility test vehicles. To test ride requests, ride proposals delivered to riders, the booking process, and vehicle dispatching, a virtual staging environment was created, including a copy of the Arlington Via rideshare service area and the RAPID service area. A waiver was developed to be displayed and accepted by all first-time RAPID AV riders in the Via system, and this process was finalized and tested.

With the completion of successful testing in the virtual staging environment and in May Mobility's headquarters test site, the team was ready for on-site testing in Arlington from February 2021 to March 2021 in preparation for RAPID service launch. This phase of testing included training AVOs on the vehicles, the route, and the Via driver application. Testing was performed using both the Lexus AVs and the Polaris WAV. Since the vehicles are a different size and have different mechanical systems for operation, it was important to test both for performance and consistency. During this time, Via created a reporting dashboard to share RAPID service and ridership data with the team, and May Mobility created a reporting dashboard to share RAPID autonomy performance data with the team. Via also trained their customer service agents on the details of the RAPID service, so they could assist riders in booking or requesting information about the service. A soft launch took place March 15 – 22, 2021, which allowed live booking and ride completion. A few minor adjustments were made to the integration during the soft launch, including adjusting booking capacity.

Communications and Outreach

Educating the community and marketing the RAPID service leading up to the demonstration involved several key elements, including branding, marketing materials, press releases, social media posts, community outreach activities, and a launch event. To guide this work, the City formed a communications subcommittee with representation from all project partners and hosted the first meeting in October 2020. With meetings every other week, this group worked on developing plans for branding, marketing, communications, outreach, and education for the project, including designing vehicle wraps, planning a launch event, and continuing community outreach and education through the life of the demonstration. The project team believed it was important for the RAPID project to have its own brand, complementary to the existing Via rideshare service in Arlington but also different enough to signal the unique nature of the RAPID service. The RAPID logo is shown in Figure 3-5, and it combines elements of the City of Arlington logo and the Via service logo. Once the RAPID logo and brand was designed, the RAPID vehicle wraps were created to complement the existing Via rideshare vehicle wraps while signaling the unique RAPID self-driving service. The vehicle wrap design and the actual Lexus vehicles and the Polaris GEM vehicle used in the demonstration are shown in Figure 3-6.

Figure 3-5 *Arlington RAPID Logo*

Figure 3-6 *Arlington RAPID Vehicles and Vehicle Wraps*

Educational and marketing materials included flyers, posters, and sandwich boards that described the service and COVID-19 safety measures taken on board RAPID. These materials were distributed throughout the service area. A detailed service website, hosted by the City of Arlington and launched in January 2021, contained information about the service area, operating times, fare payment, how to book a ride, and details about the AV technology. The UTA parking website was updated with information about RAPID in March 2021.

Community outreach events prior to service launch included a series of focus groups conducted in August 2020. Three focus groups were held, one for the public, one for the UTA community, and one for people with disabilities, to gather feedback about existing transportation services in Arlington, share details about the upcoming RAPID service, and gather input on the RAPID service. City of Arlington staff gave presentations to several community groups and to the Arlington City Council. UTA staff participated in a student-focused activities fair to promote the RAPID service to the UTA community in January

2021, at the start of UTA's spring semester. The project team also coordinated a series of first responder training sessions, led by May Mobility staff, to educate city police and fire personnel and UTA first responders to the vehicles and service. First responders participated in a virtual workshop and had opportunities to visit the May Mobility office to see the vehicles in person.

A demonstration launch event was held on March 23, 2021, at a location within the RAPID service area, adjacent to the local offices of May Mobility, and in a retail development that is a key destination within the service area. The Arlington mayor, the UTA president, and the May Mobility CEO made brief remarks at the event and were available for media interviews. Attendees were able to take rides on the RAPID vehicles and experience the technology and service. The launch event was publicized with several outreach activities, including a naming contest for one of the RAPID fleet vehicles led by May Mobility, creation of a video package for media use, announcement of the service by Arlington's mayor at his annual state of the city address just prior to launch, distribution of print marketing materials on UTA's campus and throughout the RAPID service area, and a social media campaign on Facebook, Instagram, and Twitter. The launch was also supported by direct communication from Via to existing account holders and issuance of a joint press release from all project partners. The RAPID launch was well attended and well publicized in the local, regional, and national news media and on social media.

Research Activities

Led by the UTA research team, the preparation for the demonstration phase of RAPID included research on best practices for shared AVs, analysis of existing transportation services in Arlington, holding focus groups to gather feedback on the proposed RAPID service, and preparing survey instruments for use during the demonstration. Literature on AV services in the United States was reviewed, including exploration of FTA's Mobility on Demand (MOD) Sandbox program projects, analysis of the best practices of app-based, on-demand ride services, and identification of determinant factors in establishing a well-integrated public transit system using app-based, on-demand services.

For analysis of existing transportation services in Arlington, the UTA team received datasets from different platforms including the Via on-demand rideshare service and Handitran, the city's paratransit service. The team cleaned the data and conducted primary data analysis to explore rider travel patterns. The data cleaning process was undertaken to make each dataset uniform and ready for analysis. For example, the Handitran data contained some rides with missing locational attributes and included rides that were requested but cancelled, which the team removed from the dataset used for analysis. The Via data contained some rides that were taken outside of service hours, which the team removed to focus the analysis on rides during regular service operations.

Findings from the literature review and the existing transportation data were shared with the research team to inform decisions about the service area, service hours, likely pick-up and drop-off location requests, and educational outreach approaches.

The UTA research team also conducted a series of focus groups designed to share information about RAPID and get feedback from the public, members of the UTA community, and community members with disabilities. Potential participants were invited to attend the focus group events through different approaches including emails to students, faculty, and staff through UTA listservs, emails to the City's email listserv, and targeted emails to organizations within the AV service area. The focus groups were conducted virtually in August 2020 and data were collected related to current transportation systems and opinions about future AV services in Arlington. After the focus groups were held, the team asked all participants to complete a follow-up survey to collect additional transportation and demographic data. Both the focus group and the survey were conducted with review and approval from the UTA Institutional Review Board (IRB). The data collected through this process was very helpful in finalizing service parameter details.

A total of 24 people participated across the three focus groups in August 2020. The focus group discussions provided helpful feedback to the project team, as well as an opportunity to share information about the upcoming RAPID service and other existing transportation services in Arlington. Key concerns or questions from the focus group participants about the proposed RAPID service included questions about the safety of AV operations (participants were pleased to find out there would be human operators in the RAPID vehicles); interest in the service area and hours of operation being expanded; concerns about the passenger capacity of the AVs; and questions about trip costs and access for those with disabilities. Many focus group participants were also excited about the opportunity for a new mode of transportation in Arlington, excited about experiencing AV technology for the first time, and pleased that RAPID would be integrated into the existing Via rideshare service.

Finally, the team prepared two survey instruments to be used during the RAPID demonstration. One short survey was distributed to every RAPID rider after completing their first ride on the service to collect feedback on their ride experience. The second, longer survey was distributed to the public to collect data on feelings about AV services and technology in general, as well as RAPID more specifically.

Evolution in the Demonstration Phase

Key elements addressed during the demonstration phase include:

- Ridership performance metrics
- Autonomy performance metrics
- Integration performance metrics
- Rider experience metrics
- Software updates
- Operational changes
- Communication and education
- Research activities

Ridership Performance Metrics

Several key ridership metrics were tracked closely during the RAPID demonstration to monitor ridership and address any necessary changes to improve service. These metrics include the total number of rides taken, rider satisfaction rates, estimated wait time between booking a ride and the ride arriving (referred to as "estimated time of arrival" or ETA), on-time pick-up performance, and percentage of rides that were shared (once shared rides were permitted starting in late July 2021). Additionally, acceptance rates were tracked as a proxy for the willingness of customers to ride in an AV. Since the AV service was fully integrated into the broader rideshare service in Arlington, any rider who requested a ride that fit the RAPID service parameters (within the service area and operating hours) would receive multiple ride proposals, including at least one for the standard rideshare service with human drivers and at least one for the RAPID service with the automated vehicles. Riders could then compare ETA and price for each proposal and select the one that best fit their needs. The acceptance rate therefore reveals how often riders selected the RAPID ride when given the choice. Monthly ridership performance metrics are shown in Table 3-1. Based on ridership data, 40 percent of RAPID riders used the service more than six times and, on average, each rider completed 13 rides over the course of the one-year demonstration.

Table 3-1 *Monthly Ridership Performance Metrics*

Month	Total Rides	Average Rider Satisfaction (out of 5)	Average ETA (minutes)	Average On-Time Performance[3]	Average Shared Ride Percentage	Average Acceptance Rate
March 23 to April 30 2021	1,043	4.9	6	100%	n/a	74%
May 2021	732	4.9	6.7	100%	n/a	80%
June 2021	1,260	4.9	9.1	99%	n/a	90%
July 2021	1,601	4.9	9.6	100%	n/a	93%
August 2021	2,697	4.9	12.6	99%	60%	88%
September 2021	3,184	4.9	14.1	99%	66%	82%
October 2021	3,404	4.9	14.0	99%	66%	87%
November 2021	3,569	4.9	13.9	99%	63%	88%
December 2021	2,608	4.9	11.8	100%	55%	90%
January 2022	3,034	4.9	12.6	99%	63%	89%
February 2022	2,967	4.9	15.5	99%	71%	83%
March 1 to 18 2022	2,041	4.9	13	100%	62%	75%

Examining the average daily ridership by week across the demonstration year also offers a helpful understanding of ridership demand and the ability of RAPID to serve daily transportation needs for many people in the service area. As shown in Figure 3-7, daily ridership averaged around 35 to 40 rides for the first several weeks of demonstration, and then ridership began climbing steadily at the end of May 2021 and over the summer. Ridership then increased dramatically in August 2021, near the start of the UTA fall semester, climbing to a peak of close to 200 rides per day in mid-November 2021. Ridership did decline significantly in December 2021 and early January 2022, during the UTA winter break, but then rose again dramatically with the start of the UTA spring semester and remained strong through the conclusion of the demonstration in mid-March 2022.

[3] On-time performance is the percentage of booked trips picked up within the pick-up window and dropped off within the estimated drop-off window.

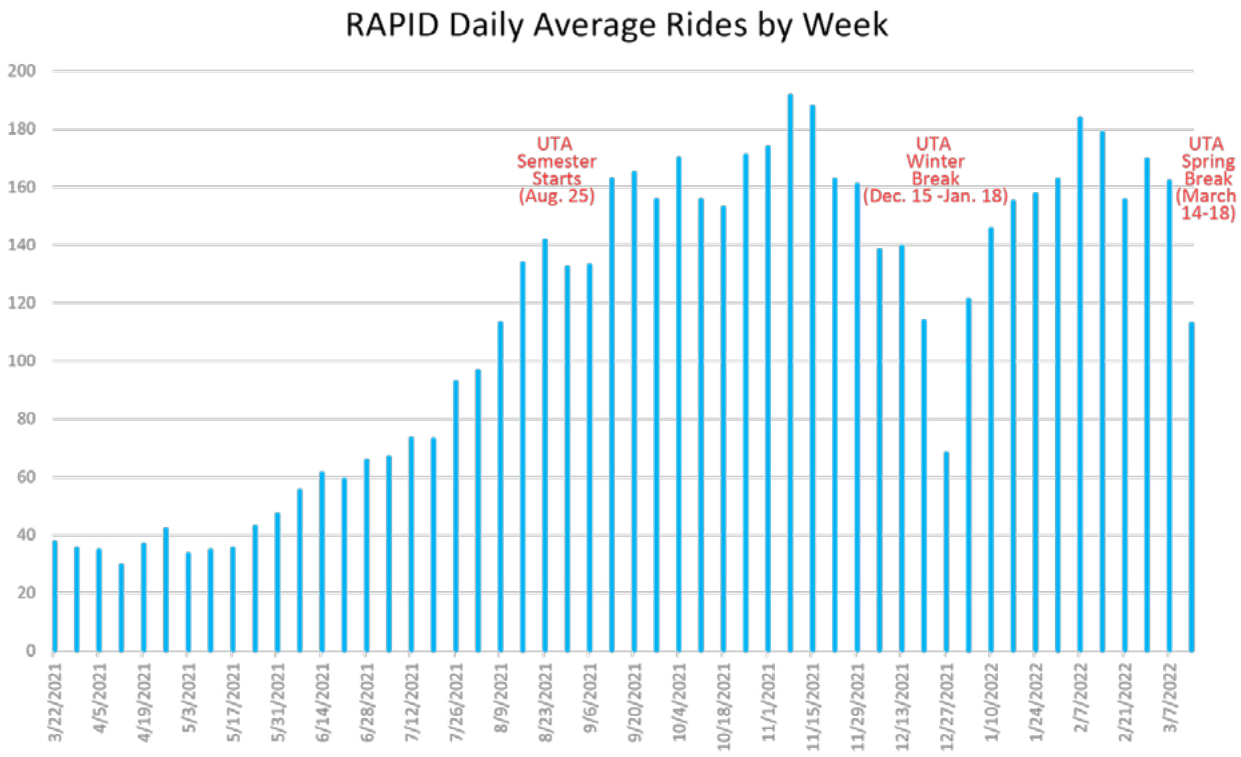

Figure 3-7 *RAPID Daily Average Rides by Week for Demonstration*

It is important to note that while the wheelchair accessible AV was available for service during the entire demonstration, there were no completed WAV rides by members of the public booking through the Via platform. Two ride requests during the year were mistaken for a WAV ride, though the passenger did not require mobility assistance. In these two cases, the ride was completed with the rider sitting in the front passenger seat of the Polaris GEM vehicle that had been dispatched. For context, the City of Arlington operates ADA complementary paratransit service for eligible persons whose disabilities prevent them from independently using the fixed route system. The Via microtransit service also provides wheelchair accessible rides, and 5 percent of all rides provided by this service were for wheelchair accessible vehicles from March 2021 to March 2022. The project team planned several events for riders with disabilities during the demonstration, and RAPID did provide rides on the wheelchair AV during these events, which provided very useful feedback on WAV design to the team. One event was with the UTA Movin' Mavs Wheelchair Basketball Team in May 2021, and one was a research event planned by a team from the Texas Transportation Institute (TTI) for people with limited mobility and vision in June 2021. Feedback from the basketball team included items related primarily to vehicle design – the need for grab bars by the wheelchair securement location, the need for good air flow and air conditioning, and the need for a WAV that is the same as for non-wheelchair passengers and allows for more than one rider to travel

together. Feedback from the TTI event included the need for the vehicles to provide audio cues for passengers with limited or no sight and to ensure that vehicle stop locations are fully accessible.

Autonomy Performance Metrics

Several key autonomy metrics were tracked closely during the RAPID demonstration to monitor performance of the AVs and address any necessary changes to improve service. These items include total percentage of time in automated mode, autonomy performance across the service area, and any incidents with the vehicles or autonomy performance.

The RAPID service area is quite complex, with challenges to automated operations including at-grade railroad crossings, unprotected left turns, and crossing a state highway. Additionally, high levels of pedestrian and bicyclist activity and construction projects contributed to challenges with autonomy during the one-year demonstration. Given the complex environment, some portions of the service area were unable to be driven in autonomy mode, such as unprotected left turns, and the AVO would drive the vehicle in manual mode in these areas. When the areas that required manual driving are removed, it is possible to better understand how well the vehicles operated across all areas where they were expected to be in fully automated mode. Figure 3-8 shows monthly average autonomy percentage for the entire fleet across the service area. Monthly average autonomy percentage represents the total percentage of time the vehicles were operating in automated mode, filtered for times when the vehicles were in a required manual zone, such as making an unprotected turn, or off-route for some reason, such as driving around a temporary construction diversion.

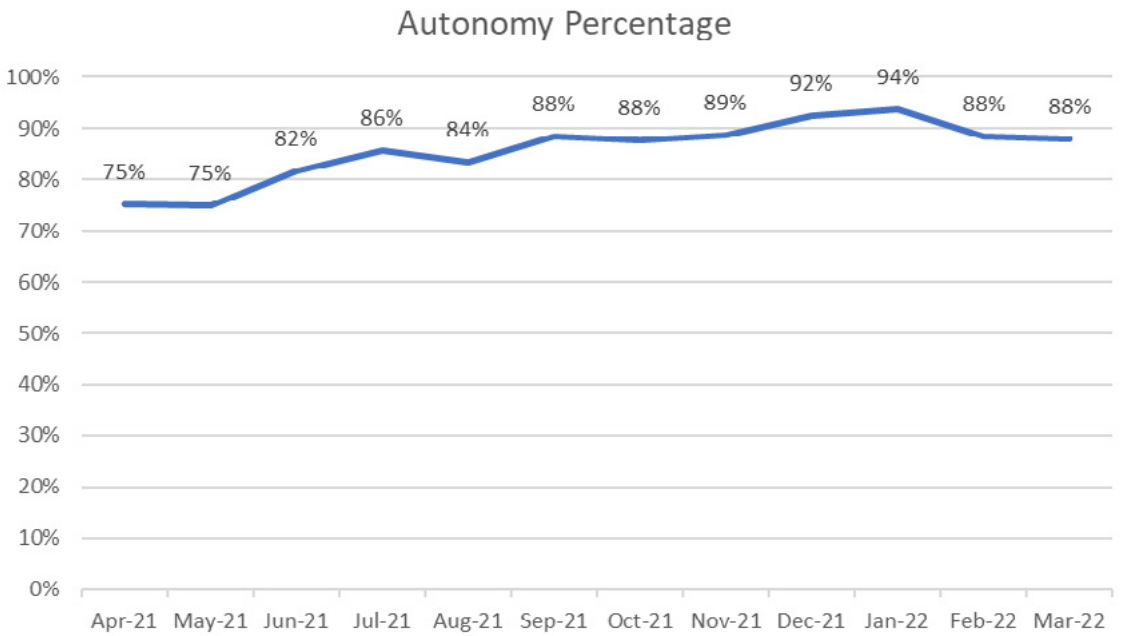

Figure 3-8 *Monthly Autonomy Performance*

Autonomy heatmaps were also used to better understand specific locations within the service area where autonomy performance was better or worse. Analysis of these heatmaps allowed project team members to identify areas of poor performance and develop targeted responses. Figure 3-9 shows the autonomy heatmap at the start of the demonstration, from launch through April 2021, and Figure 3-10 shows the autonomy heatmap at the end of the demonstration, in March 2022. A comparison of the heatmaps shows that while some areas retain low autonomy performance (blue and black areas), many areas have significantly higher autonomy performance (red areas).

Some autonomy challenges identified and addressed over the course of the demonstration include traffic light detection, dense or overgrown vegetation, changes at construction sites, narrow roadway lane widths, and increased pedestrian activity during key points in UTA's semesters. There were also decreases in autonomy due to heavy rain events in January 2022, winter weather and freezing temperatures in February 2022, and construction activities on the route in March 2022, when AVOs operated in manual mode to prioritize safety in these conditions. Additionally, slight modifications were made to the route network during the demonstration to improve vehicle dispatch to popular stops and to allow the vehicles to return to their operational base in automated mode. The route network map was also updated at several points during the demonstration to update changed conditions, such as completed construction projects and new lane markings on roadways.

Finally, there were specific times when the AVOs would disengage automated mode and operate the vehicle manually. These disengagement events fall into the following categories:

- Required manual zones, such as unprotected turns
- Passenger stops
- Traffic signals
- Long waits when the passenger is not at the stop when the vehicle arrives
- Shift end, when the AVO is returning the vehicle to the garage
- Health drops, when vehicle behavior is not as expected and the AVO takes over to prioritize safety
- Unknown events, such as the vehicle taking an unexpected hard stop or an obstacle blocking the route.

Figure 3-9 *Autonomy Heatmap for Beginning of Demonstration (March – April 2021)*

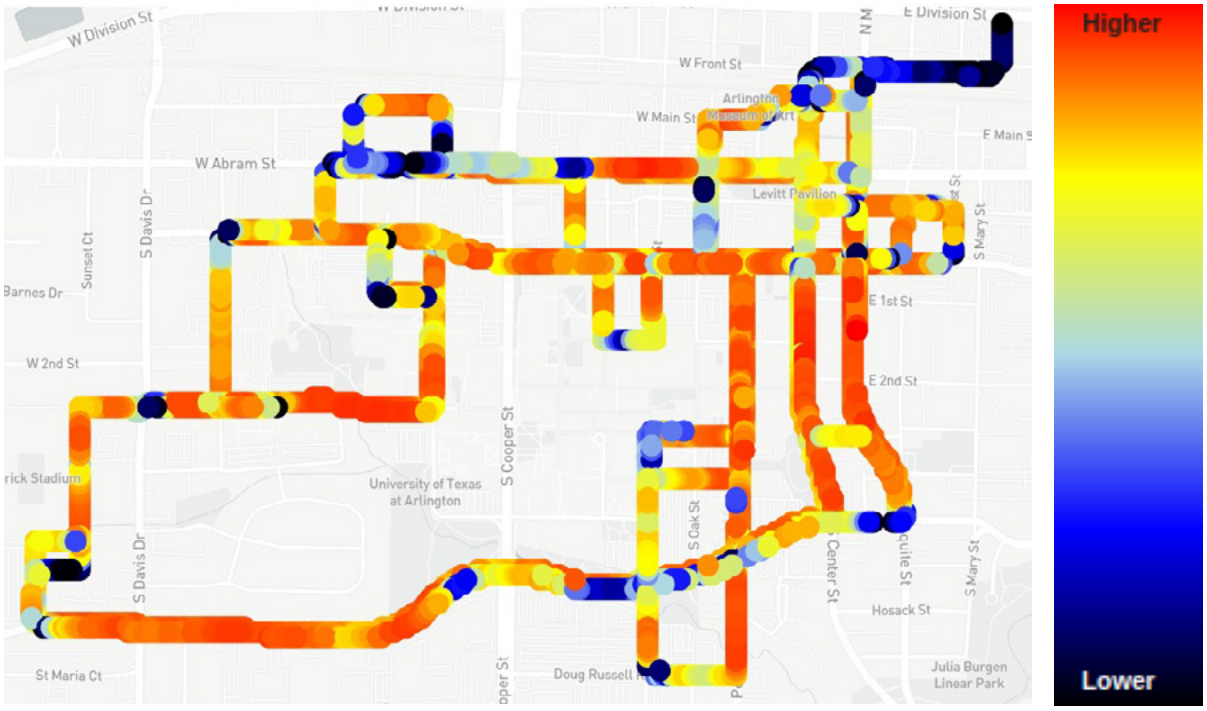

Figure 3-10 *Autonomy Heatmap for Last Month of Demonstration (March 2022)*

As described above, the project team developed a detailed process for responding to any incidents that might occur during service. The service experienced no safety accidents or collisions of any kind, either in automated or in manual mode, during the demonstration. However, there were five minor incidents where the vehicles did not perform as expected in automated mode, called optics events, which were thoroughly investigated even though they did not result in any damage or injuries. A summary of each optic event is provided in Table 3-2.

Table 3-2 *Optics Events Details*

Date	Riders	Vehicle Speed	Autonomy Status	Details
Sept. 3, 2021	1	<5 mph	Auto	Curb rub during a right-hand turn
Oct. 11, 2021	0	<5 mph	Auto	Curb rub during a right-hand turn
Nov. 22, 2021	1	22 mph	Auto	Curb strike while driving
Dec. 1, 2021	1	<5 mph	Auto	Curb rub due to AVO error at passenger stop
Jan. 31, 2022	1	<5 mph	Auto	Curb rub after passenger stop

Immediately after each of these events, staff from the May Mobility engineering and technical support teams reviewed vehicle logs and camera footage to determine what occurred and how to address the incident. In most cases, the events were due to the lane placement in the detailed route network map, and the map was adjusted to ensure the vehicles were not permitted too close to the curb in future turns. The one event due to AVO error was an opportunity for retraining all AVOs on proper protocol at and around passenger stop locations.

Integration Performance Metrics

Strong integration between the Via and May Mobility platforms and services was necessary for the RAPID service to succeed. During the demonstration, the project team monitored and assessed integration performance using the following metrics:

- Cloud and vehicle connectivity
- Vehicle task execution
- Vehicle status updates
- Performance of the Via system for booking and paying for AV rides, as well as making AV rides free to eligible UTA students.

Within each of these metrics, minor issues were noted and addressed during the demonstration.

Cloud and vehicle connectivity:

- Isolated incidents of connectivity between the May Mobility and Via systems were experienced at times during the demonstration. Generally, these issues were resolved by paying careful attention to the order of operations when logging into the May Mobility vehicle and Via driver app. Occasionally restarting an operator's shift or the driver's app was required.
- The WAV in the fleet did not always appear in the correct location when parked in the office/garage because of the strength of signal connectivity inside the facility. To solve this issue, the team drove the WAV more frequently to bring it outside, allowing for better localization and signal and thus readiness for service.
- An AVO leaving a location prior to being dispatched by the Via system sometimes led to issues with connectivity and displaying the true location of the vehicle for dispatch purposes. This was resolved by training the AVOs to wait for dispatching before leaving their location.

Vehicle Task Execution:

- At the beginning of the demonstration, it was determined that the AV ETAs were sometimes excessive, resulting in the AV arriving at pick up locations several minutes before the Via driver app or rider app indicated the vehicle's arrival time. The Via and May Mobility teams investigated, and Via adjusted the ETA algorithm to better sync with actual AV performance after the launch of the service.
- Once shared rides began in July 2021, the project team realized there were times when the AV routing was less than ideal or somewhat inefficient, likely caused by parameters of the AV route network map — the subset of roads safe for the Avs to travel on autonomously. Where practical, AVOs would at times switch to manual mode to make pick up and drop off more convenient for passengers. To advance a longer-term resolution, the Via and May Mobility teams investigated these instances and made recommendations to improve future pre-launch planning and service design processes.
- Construction in the service area also posed challenges for the vehicle task execution, as new construction projects obstructing or partially obstructing the route network required AVOs to switch to manual mode to navigate around the construction obstructions. The May Mobility and Via teams were able to update maps to accommodate construction projects, allowing the vehicles to remain in automated mode more often.
- When the service was launched, the vehicles were not programmed to return to the office/garage location at the end of a shift or end of the service, which required AVOs to drive in manual mode, which reduced overall autonomy performance. Via was able to add automated dispatching to the office/garage base for the end of shifts and end of service in June 2021.

Vehicle Status:

- Riders noted that heat was coming from the rear of the vehicle, generated in part by the computers in the trunk space of the vehicles. Challenges caused by extreme weather, such as heat, are common across the AV industry today. The engineering team at May Mobility designed a box and ducting that collects the heat from the computers and vents it outside through the rear passenger side wheel well. As COVID-19 conditions improved, the project team also decided to remove the vehicle partition between the AVO and rider in July 2021, which resulted in better air flow. Both measures improved rider comfort in the vehicles.
- Riders also noted sound coming from the rear of the vehicle, also generated by the computers in the trunk. An engineering team of UTA students, led by Dr. Yawen Wang, studied the issue and designed a 3D printed, sound muffling box to fit around the ductwork attached to the vehicle's computer. The box made a measurable reduction in noise reaching the passenger areas, and this solution was expanded to all fleet vehicles. A student from Dr. Wang's team won an award for this work.

The final integration performance metric was related to the performance of the Via system for AV ride functions, including booking and paying for AV rides and ensuring AV rides were free for eligible UTA students. All booking and paying functions in the Via system functioned smoothly for the AV rides – Via users received offers for AV rides when their ride request met the AV service parameters, and users were able to select, book, and pay for AV rides seamlessly in the Via app and through the Via call-in center. UTA students eligible for free rides on RAPID received these free rides by using their UTA student email address on their Via account. This information was made clear in RAPID marketing and other information, but the project team did field some questions from UTA students who did not receive free rides, and these students were reminded to use their student email address. The project team also fielded some questions from UTA students who were eligible for free rides but would receive a ride charge if the student booked and then subsequently cancelled the ride or did not show up for their ride. The project team discussed this situation and decided that even though UTA students should receive free rides, they should be subject to standard cancelation charges, as these behaviors decrease overall service efficiency and impact the experience for other riders.

Rider Experience Metrics

Rider experience was tracked closely during the RAPID demonstration using several methods, including informal comments to and discussions with May Mobility AVOs, the Via in-app ride satisfaction rating, and survey responses. Any issues or comments from riders that were shared with AVOs were discussed and addressed by the project team, and these comments were generally positive.

Most negative rider comments were related to vehicle climate control and noise (discussed above) and compliance with wearing masks while on-board, in accordance with FTA regulations. The Via in-app ride satisfaction rating is a prompt that all riders receive in the Via app after completing each ride on RAPID. The rating is based on a scale of 1 (unsatisfied) to 5 (very satisfied) stars. As presented in Table 3-1, this rating for RAPID was very high, with an overall average of 4.9 out of 5 stars for the demonstration.

Additional key indicators of rider experience, as well as other information about riders, was obtained from survey responses. The short survey developed by the UTA research team was sent to each rider after completing their first ride on RAPID, as well as promoted through project websites and other outreach. This survey asked questions about trip purpose, aspects of the trip experience such as booking and safety, other transportation modes used, and sociodemographic data. For the entire term of the demonstration, a total of 402 responses were received for this survey, of which 261 completed the entire survey.

Survey respondents reported using RAPID for a range of trip purposes, including travel to school, work, shopping, and recreation (Figure 3-11). RAPID riders also reported using a range of other transportation modes, including private vehicles, the Via rideshare service, private ride-hailing services, and the UTA campus shuttle service (Figure 3-12).

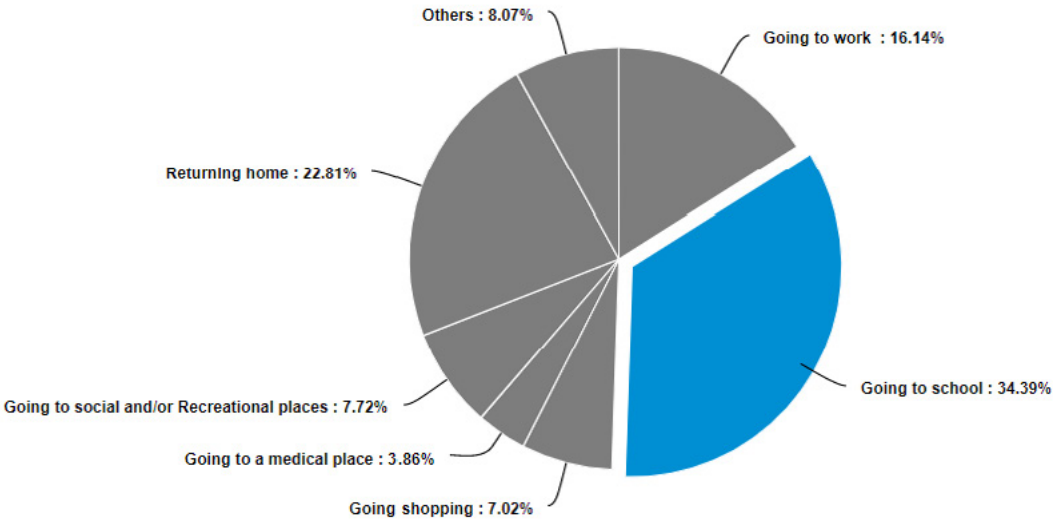

Figure 3-11 *Survey Responses: Trip Purpose on RAPID (n=295)*

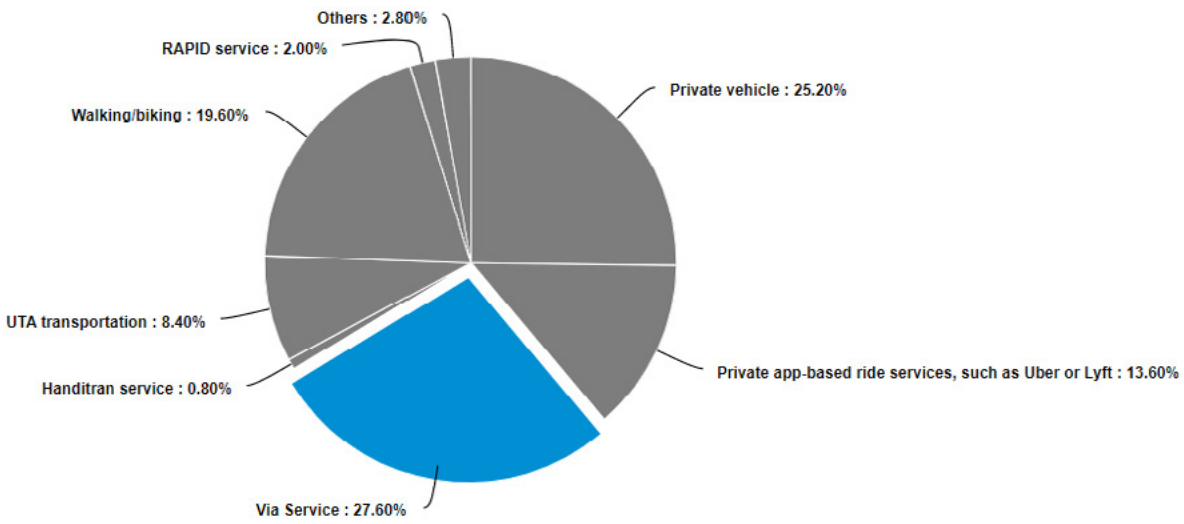

Figure 3-12 *Survey Responses: Modes of Transportation Used in Addition to RAPID (n=261)*

Survey questions about RAPID trip experiences asked respondents how strongly they agreed with various statements, with response choices of strongly agree, agree, neutral, disagree, strongly disagree, and not applicable. RAPID riders reported high levels of satisfaction with most aspects of the trip experience, as shown in Table 3-3 where responses of strongly agree, agree, and neutral are reported (excluding disagree, strongly disagree, and not applicable responses). Respondents rated key trip elements highly, including easy booking (92 percent agree), easy boarding (96 percent agree), and seat comfort (98 percent agree). Lowest rated elements included reasonable wait time (80 percent agree) and pickup and drop off locations were convenient (83 percent agree), which may be due to the high demand experienced during a majority of the demonstration and the nature of shared rides with aggregated pickup and drop off locations. Notably, 97 percent of respondents agreed that they felt safe riding RAPID, 94 percent agreed that they felt safe while sharing a ride on RAPID, and 98 percent agreed that they would ride RAPID again in the future.

Table 3-3 *Survey Responses: RAPID Trip Experience (n=298)*

Question	Riders who Agree
Booking and scheduling my RAPID trip using the Via app was easy	92%
The price for riding RAPID was reasonable	96%
The wait time was reasonable	80%
The pick-up and drop-off locations were convenient	83%
Boarding the vehicle was easy	96%
The seats in the vehicle were comfortable	98%
The climate control in the vehicle was appropriate	93%

Question	Riders who Agree
The speed of the vehicle was reasonable	92%
I felt safe when riding RAPID	97%
I felt safe while sharing the vehicle on my RAPID ride with other passengers	94%
I would ride RAPID again in the future	98%

Survey questions about sociodemographic characteristics show the following of RAPID riders:

- 79 percent report being non-white
- 56 percent report having an annual household income of less than $20,000
- 47 percent report having no access to a personal vehicle
- 79 percent report being a UTA student
- 54 percent report being 18-24 years old
- 68 percent report being male

To receive more in-depth feedback regarding rider experiences on RAPID, the UTA research team conducted individual interviews with 11 people after the conclusion of the demonstration. Of these 11 interviewees, seven had ridden RAPID and six out of these seven were UTA students. While the interview results are not representative of all RAPID riders, some key insights resulted from the interviews. Like the survey findings, interviewees reported satisfaction with using the Via app to book RAPID rides and found RAPID rides to be comfortable. They also reported some issues with longer wait times for some rides, as well as receiving aggregated pickup and drop off locations, rather than at their exact desired locations. Interviewees also raised some questions about the ability of the AV technology to perform in all areas and situations in the service area, such as needing the AVOs to take over in manual mode for some turns. They did report several benefits of the RAPID service and AV technology more broadly, including the ability to multitask while riding, affordability, safety improvements, and environmental benefits of shared AVs. Interviewees also reported some concerns about general lack of trust in AV technology and challenges with communication once AVOs are removed from the vehicles, but notably, while some interviewees reported feeling skeptical about riding in AVs, they stated that they became more confident after experiencing the technology firsthand and having an opportunity to ride and understand how AVs work.

In addition to conducting individual interviews, the UTA research team also held a focus group to discuss the service after the conclusion of the demonstration. A total of four participants attended the focus group, of which one had ridden RAPID and three had not ridden RAPID. While the size of the focus group limits representativeness to all RAPID riders, the group discussion yielded some helpful insights and feedback. Some challenges with automated and shared

services that were discussed include wait times when booking a ride, walk distances to pick-up locations, and the inability to serve a large geographic area. The benefits of the service discussed by the group include increasing options for mobility, environmental benefits of shared and hybrid electric vehicles, and greater flexibility compared to fixed-route services. Awareness of the service was mentioned as a barrier to using the service, suggesting that marketing campaigns must be robust with new transportation services. Additionally, price, geographic coverage, and convenience were mentioned as key factors for riders when they make decisions about which transportation modes to use.

Software Updates

Several software updates were released by May Mobility to the RAPID vehicle fleet during the demonstration. Software updates included both proactive elements developed by the May Mobility team, such as new vehicle health monitors and new dash displays, as well as elements developed in response to data collected during service, such as updates to maps due to changes in the operating environment or to improve the ride feel for passengers. These updates led to noticeable improvements in automated performance in the Arlington service area. The following list provides a summary of the key software updates made and their impacts:

- May 2021: software update related to traffic light detection, allowing the vehicles to better read traffic lights, and decreasing times when AVOs needed to intervene manually to navigate intersections with traffic lights
- July 2021: software update related to the tracking of other vehicles on multilane roads to improve prediction of the future paths of other vehicles
- August 2021: software update related to adjusting deceleration zone for Avs following other vehicles, for improved safety and performance
- December 2021: software update related to vehicle movement in lanes and around curves, as well as improved prediction of other objects around the vehicles
- March 2022: software update related to allowing vehicles to stay in full automated mode at passenger stops

Operational Changes

There were several operating changes made to the RAPID service during the demonstration, based largely on rider feedback. When the service launched in March 2021, the project team instituted several COVID-19 health and safety measures, including partitions between the AVO and rider spaces, UV-C light disinfection between each ride, and single-ride bookings only. In July 2021, due to improved health conditions, the project team decided to remove the partitions, discontinue UV-C light disinfection between each ride (although this disinfection was still done several times throughout the day), and allow shared-

ride bookings. These changes allowed better air flow in the vehicles without the partitions, shorter ETAs without the UV-C light disinfection time, and higher ridership through shared rides. Riders appreciated these changes, and no negative impacts were identified. Masks were required on board for all AVOs and riders for the entire demonstration, in keeping with FTA regulations.

RAPID service operating hours were also adjusted during the demonstration. At launch, operating hours were Monday to Friday from 7 a.m. to 7 p.m. However, based on rider demand patterns and rider feedback that showed interest in the service later in the day, the operating hours were adjusted in early January 2022 to run Monday to Friday from 8 a.m. to 8 p.m. This operational change was communicated to riders before it went into effect, and ridership remained strong after the change.

Communication and Education

After the large-scale marketing and outreach campaign at the launch of the RAPID service, the project team remained committed to ongoing and targeting communication, marketing, and education during the entire demonstration. The City of Arlington maintained a website with detailed service and project information throughout the demonstration, along with targeted news stories and social media posts at several times. Likewise, the UTA Parking and Transportation Department maintained information about RAPID on its website and continued to advertise the service across multiple platforms on campus. Via provided operational announcements and reminders to riders using email and in-app notifications. Throughout the demonstration, the May Mobility team shared news stories and social media posts highlighting the service.

Research Activities

The UTA research team, supported by the entire project team, continued robust research activities during the demonstration and in the period shortly after the demonstration. The two surveys described above, one shorter survey focused on rider experience and one longer survey focused on attitudes toward AV service more broadly, were active for the entire demonstration. The UTA team set up an online dashboard where the project team could access raw survey results and prepared a summary report of survey responses each month for the project team. The UTA team analyzed ridership data each month, including data about date and time of rides, ride distance and duration, ride cost, rider type (UTA student status), and average wait times. A summary of key trends in the data was provided by the research team each month.

After the conclusion of the RAPID demonstration, as discussed above, the UTA team conducted several interviews with RAPID riders to elicit more detailed observations and experiences with the service. Additionally, a final focus group was conducted with representatives from the UTA community and the public

to discuss the impacts of the service. All findings from research activities were shared with the project team, as well as more broadly through academic journal articles and conference presentations to support knowledge transfer activities, discussed in greater detail in the next chapter of this report.

Evolution of Key Challenges

There were several key challenges that the RAPID project team addressed and overcame to successfully launch and deploy RAPID. These challenges fall into the following categories:

- COVID-19 impacts
- Rider experience
- WAV utilization
- Integration between provider platforms

COVID-19 Impacts

The COVID-19 pandemic affected many aspects of the RAPID project, from supply chain constraints on vehicle availability to UTA's schedule and uncertainty about ridership demand. Overall, while there were delays with vehicles and other hardware components, as well as challenges from travel limitations, the project team was able to adapt and stay on schedule for launch in March 2021. At the time of launch, many of UTA's classes were operating online, rather than in-person, and many offices in the RAPID service area were conducting remote work or work-from-home protocols. These conditions led to uncertainty about rider demand for the RAPID service, coupled with national trends showing declined ridership on all forms of public transit. As expected, ridership was low on RAPID for the weeks immediately following launch, but starting in summer 2021, ridership climbed steadily, and strong demand remained for the service through the conclusion of the demonstration in March 2022. The project team also implemented several COVID-19-related health and safety measures, along with complying with all FTA health measures, which were included in marketing and messages to riders. It is believed that these efforts helped to make riders feel more comfortable riding the service.

Rider Experience

With respect to the rider experience (aside from concerns about COVID-19), there were two key complaints shared by riders in conversations with AVOs and in feedback surveys – excessive heat and noise generated by the computer system in the trunk space of the AVs. Both issues were addressed through engineering teams at May Mobility and at UTA to decrease heat and noise, thereby improving rider comfort. Otherwise, the rider experience, as measured by responses to in-app prompts and to surveys was quite positive.

WAV Utilization

While the RAPID service provided a wheelchair accessible AV as part of the fleet, marketed the availability of this vehicle, and performed outreach to groups of people with disabilities in the RAPID service area, there were no organic completed rides on the WAV. Based on feedback gathered through outreach events, two key concerns were identified about the RAPID WAV – the different vehicle type for WAV rides and the inability to book for more than one rider in the WAV. While the different vehicle type and passenger limitation was unavoidable due to COVID-19 supply chain issues mentioned above, the project team maintained efforts to bring a new vehicle type to future RAPID operations, which will provide WAV rides on the same vehicles as all other rides and allow for flexible configurations, including both WAV and non-WAV passengers at the same time in the same vehicle. Additionally, feedback received from outreach events was incorporated into RAPID operations, such as the installation of grab bars in the vehicle for passenger comfort, and efforts taken by May Mobility to improve accessible design features in their vehicles. May Mobility partnered with the University of Michigan Transportation Research Institute, along with others, to participate in the U.S. Department of Transportation's Inclusive Design Challenge, and real-world lessons learned from the RAPID demonstration helped to inform their work on this challenge. The RAPID demonstration and the Inclusive Design Challenge also directly informed design decisions for the new May Mobility vehicle, which is a Toyota Sienna specially designed for automated and accessible public transportation. The Toyota Sienna deployed for the Arlington RAPID service in fall 2022 is shown in Figure 3-13.

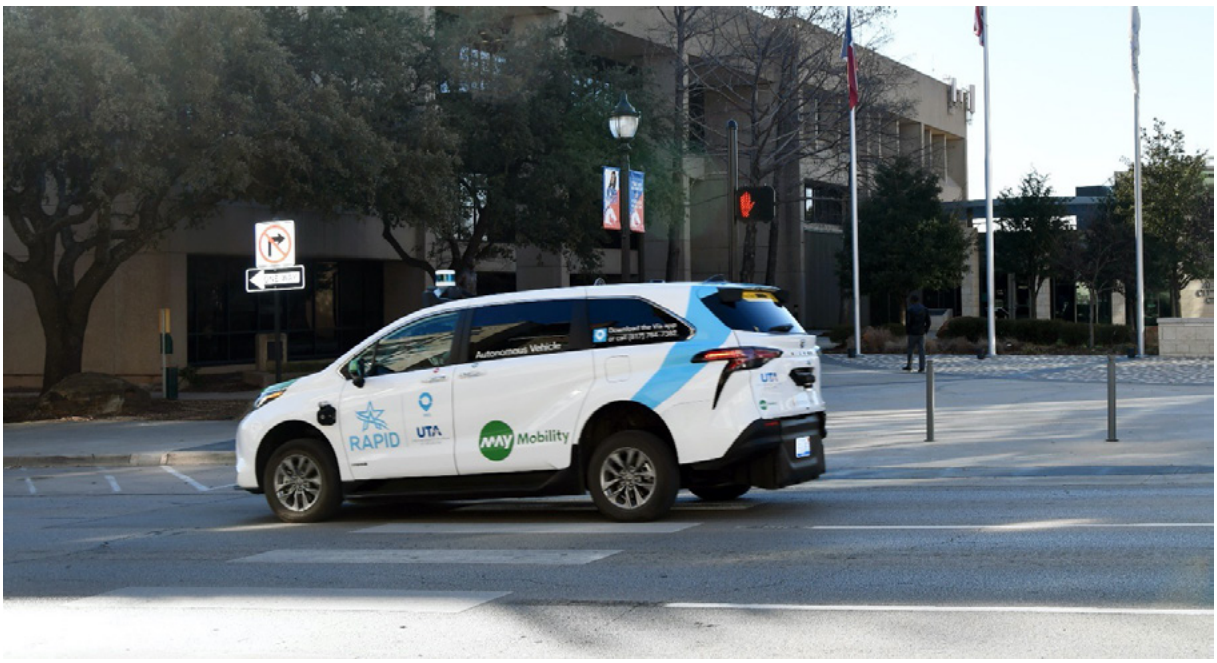

Figure 3-13 *Toyota Sienna RAPID Vehicle*

Integration between Providers Platforms

At the outset of the RAPID project, it was known that seamless integration between the Via and May Mobility platforms would be a project challenge, and the team tackled integration issues from the beginning. With extensive testing before demonstration and clear communication during demonstration, all significant integration issues were avoided. While there were some minor integration issues, as described above, they were all addressed and corrected during the demonstration, resulting in smooth and functional service and integration across platforms.

Overall, the experience of the FTA IMI-funded RAPID demonstration has significantly advanced the goals and knowledge of the project team across a wide range of functional areas, including technology performance, vehicle design, rider experience, technology integration, safety, and accessibility. RAPID saw high rider demand and support for an AV service integrated into existing on-demand public transit, as well as success at this new service provision. In all its AV testing, the City of Arlington has had two main goals – testing technology in real-world settings and educating residents about AV technology to improve acceptance. With the success of RAPID, both goals have been advanced significantly.

Section 4

RAPID Project Evaluation

Evaluation of the RAPID project can be achieved through comparison of the information presented in the previous chapter to the stated project objectives listed in the Project Description chapter and established at the outset of the RAPID project. Additionally, as sharing of lessons learned from this demonstration was a key goal, this chapter will also provide an evaluation of the knowledge transfer activities performed by the RAPID project team.

Evaluation of Project Objectives

There are six project objectives that were established for the RAPID project, and each will be evaluated in turn:

- Increased access for senior citizens, students, and individuals with disabilities
- Improved equity and accessibility to public transit
- Improved safety and efficiency
- Demonstration of automation on an existing public transportation system
- Demonstration of integrated ride booking and payment between modes
- Use of public-private partnerships for demonstration, data sharing, and knowledge transfer

Increased Access for Senior Citizens, Students, and Individuals with Disabilities

Ridership data and survey results were used to evaluate how RAPID increased access for all, with an emphasis on underserved groups including senior citizens, students, and individuals with limited personal mobility. While demographic data were not collected on all riders, survey responses can serve as a proxy for some conclusions about general RAPID rider characteristics. Figure 4-1 shows the age distribution of survey respondents, which reveals that the majority of riders were 18 to 24 years old (54.5 percent of survey respondents) and only 0.4 percent of survey respondents were 65 years or older, suggesting that senior citizens were not a key rider group for RAPID. However, we do see that most RAPID riders were UTA students, with a total of 98.5 percent of all rides on RAPID taken by UTA students.

Regarding RAPID providing service to individuals with disabilities, this metric was evaluated in two ways. The first evaluation used by the project team relates to individuals with a disability that limits their mobility. While the wheelchair accessible AV was not used to complete rides for individuals requiring this mode, it is quite possible that the provision of RAPID allowed riders with a mobility disability that did not require a WAV to access destinations more easily and conveniently within the busy service area. For some additional context, it is

important to note that senior citizens and individuals with disabilities may have been less likely to travel during the time of the RAPID demonstration due to increased risk from COVID-19 health concerns. Additionally, the City of Arlington has an established ADA complementary paratransit service available for eligible persons whose disabilities prevent them from independently using the fixed route busy system. Finally, while ADA accessible vehicles are provided on the City of Arlington's broader Via rideshare service, data from the first one and half years of city-wide service shows that only about 4 percent of all rides taken were from riders needing WAVs. As the RAPID service was part of the broader rideshare service, it is reasonable that there would also be low demand for WAV rides on RAPID.

A second evaluation regards access to modes of transportation to meet the needs of individuals. RAPID rider survey results show that 47.3 percent of respondents do not have access to a personal vehicle at all, while an additional 32.8 percent of respondents have one vehicle available to their household. Income can also be a proxy for personal mobility, and survey results show that 73.8 percent of RAPID riders had an annual household income of less than $35,000 (Figure 4-2). It is clear that the RAPID service increased access for riders in the service area, especially for UTA students and for individuals with limited access to other forms of personal mobility.

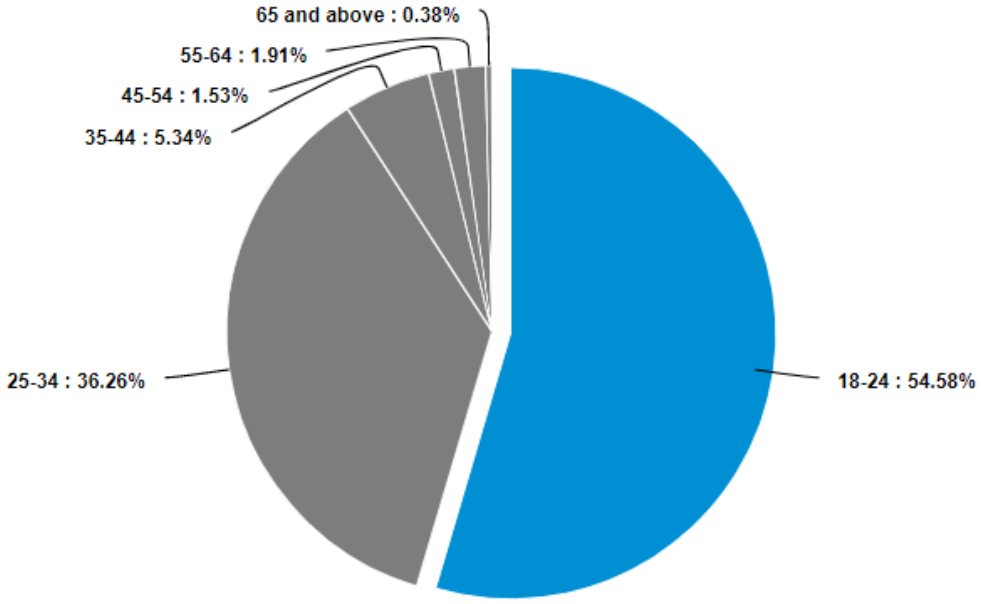

Figure 4-1 *Age Distribution of RAPID Riders, Based on Survey Responses (n= 262)*

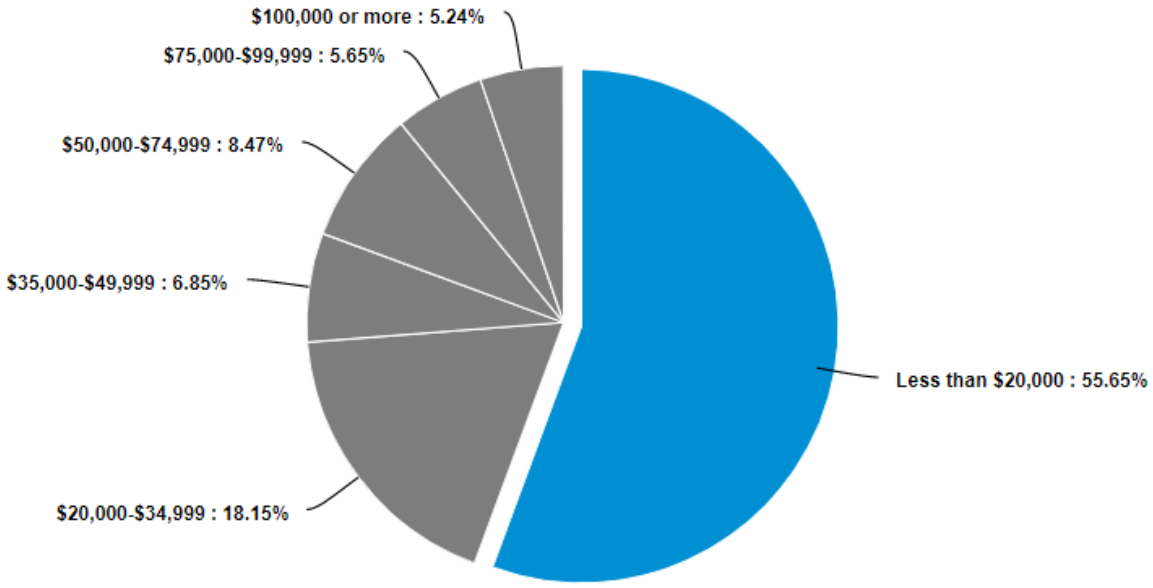

Figure 4-2 *Annual Household Income Distribution of RAPID Riders, Based on Survey Responses (n= 248)*

Improved Equity and Accessibility to Public Transit

Evaluation of how RAPID improved equity and accessibility to public transit was also performed using ridership data and survey responses. Given the dramatic increase in ridership over the course of the RAPID demonstration and the average of close to 200 riders per day taken on RAPID during November 2021, it is clear that the RAPID service provided a needed transportation option for individuals in the service area. For context, the Via microtransit service in Arlington also saw significant growth during this time period, with a 9 percent compound monthly growth rate in 2021 that led from an average of 16,500 monthly rides to an average of 48,300 monthly rides over the course of the year. Additionally, 25 percent of monthly rides in 2021 were from riders new to the service. It is also clear that RAPID riders used a variety of other transportation modes to meet their needs. As described in the previous chapter, RAPID riders also used the broader Via rideshare service, personal vehicles, walking or biking, UTA campus shuttles, and private ride-hailing services (Figure 3-12). By introducing a new mode, RAPID provided another option, and, for UTA students, RAPID was also a free option, helping to increase equitable transportation for this underserved group.

More broadly, the RAPID service sought to ensure equity and accessibility by providing a wheelchair accessible AV in the fleet, both a smart phone application with accessibility tools and a call center for booking rides or getting information, and accepting pre-paid credit cards that riders can purchase with cash to make fare payments. More details can be found in the RAPID Equity and Accessibility Plan approved by FTA.

Improved Safety and Efficiency

The RAPID project was able to provide a consistently safe and efficient service for the full duration of the one-year demonstration. Regarding safety, as described above, there were no safety accidents or collisions of any kind, either in automated or in manual mode, during the demonstration. There were five minor incidents, commonly referred to as curb rubs, where the vehicles did not perform as expected in automated mode. While these incidents did not result in any damage, injuries, or safety concerns, they were thoroughly investigated, and the lessons learned were used to improve service and performance moving forward. More information on these incidents is presented in the section above, Autonomy Performance Metrics.

Regarding efficiency, there are a few quality-of-service metrics that demonstrate the efficient operations of the RAPID service. As discussed in the previous chapter, the RAPID service ETA after booking a ride fluctuated with demand, with monthly averages ranging from a low of six minutes at the start of service to a high of 15.5 minutes. This range of average ETAs is in line with ETA performance on Arlington's broader rideshare service, and the ETAs decreased over the course of the service as demand increased for the AVs. On-time percentage for the RAPID was quite high, with monthly averages of 99 percent and 100 percent, illustrating that routing and dispatching estimates were quite accurate for the AVs within the Via platform. Trip duration is harder to compare to the broader Via rideshare service, as the RAPID service area was quite small (one square mile) compared to the entire service area (99 square miles). However, the average trip duration on RAPID was approximately seven minutes, suggesting efficient routing and service delivery within the busy service area.

In combination, these safety and efficiency results suggest that AVs can perform as well as human-driven ridesharing services.

Demonstration of Automation on an Existing Public Transportation System

Analysis of autonomy performance and integration between the Via and May Mobility platforms reveals that the RAPID AVs were successfully integrated into the existing Via rideshare service in Arlington across all metrics and that automated performance improved over the course of the demonstration. Regarding autonomy performance, data presented in the previous chapter shows that the amount of time RAPID operated in automated mode ranged from a low of 75 percent to a high of 94 percent, revealing significant learning and improvement over the course of the demonstration. Autonomy heatmaps of the service area also show individual areas of improvement because of software updates that were applied, improvements to the autonomy map, and implementing lessons learned.

Overall, the AVs performed quite well on Arlington's existing rideshare service. There were a few challenges with integration between the Via and May Mobility platforms, mostly around use of the Via driver app by May Mobility AVOs and correct calculations of AV ETAs by the Via system. However, these challenges were all addressed quickly, and the project team was always able to maintain availability of AV service as part of the transportation system. The mere fact that over 28,000 rides were provided on RAPID over the course of the one-year demonstration is a testament to the success of AV integration with public transit.

Demonstration of Integrated Ride Booking and Payment Between Modes

Central to successful demonstration of AVs on public transit is integrated ride booking and payment functions for riders within the combined service. As described above, all booking and payment functions, which were hosted by the Via platform, functioned smoothly for the AV rides. Riders received AV proposals when their ride request parameters met the RAPID service, and riders were able to select, book, and pay for AV rides seamlessly in the Via app and through the Via call-in center.

Use of Public-Private Partnerships for Demonstration, Data Sharing, and Knowledge Transfer

The RAPID project team included two public entities, the City of Arlington and UTA, and two private entities, Via and May Mobility. Throughout the entire RAPID project, representatives from all four entities played an active and productive role in preparing for and operating the demonstration, and sharing lessons learned. Central to the team's approach were clear communication of project goals, deliverables, and objectives. Weekly project team meetings and willingness to share data also contributed heavily to the successful partnership. Data sharing between all partners led to the robust analysis presented in this report, as well as to ongoing refinements and improvements during the demonstration. Willingness to share information and discuss details led to a robust service operation, high ridership, and high rider satisfaction with the service. Additionally, the team performed significant knowledge transfer of lessons learned and data analysis from RAPID, discussed in greater detail in the following section.

Knowledge Transfer

Sharing information about the RAPID service has always been a key goal of the project team. To this end, three main areas of knowledge transfer activities have occurred:

- Academic research
- Community outreach events
- Team member presentations

The UTA research team led a robust academic research program, building on data shared from other project team members and data gathered by the UTA team from their focus groups, surveys, and interviews. These efforts have resulted in the following products:

- Journal Articles: six published articles in top academic journals, with five under review and three in preparation
- Conference Proceedings: eight conference papers published in the proceedings of the American Society of Civil Engineers (ASCE) International Conference on Transportation and Development
- Conference Posters: 17 posters presented or published for conferences, including the 2021 and 2022 ASCE International Conference on Transportation and Development and the 2022 and 2023 Transportation Research Board (TRB) Annual Meeting
- Research Reports: five reports prepared for submission to FTA and one in preparation

The project team also pursued a variety of community outreach events, both before and during the RAPID demonstration. These events served to raise awareness about RAPID for Arlington residents and visitors, ranging from UTA students, people with disabilities, and families. A summary of these events follows:

- Ten activities in and around the RAPID service area to market the service and educate attendees about AV technology, including a service launch event on March 23, 2021
- Four outreach activities for people with disabilities
- Two videos highlighting the RAPID service, including an episode of the City of Arlington video series "On the Clock" and an episode of the Discovery Channel show "It's How You Get There," both released in August 2021

Finally, members of the RAPID project team provided presentations on RAPID at over twenty public and private conferences and webinars. Notable webinars include one hosted by PAVE in February 2022 and one hosted by Cities Today in June 2022. Additionally, City of Arlington staff have participated in calls from the Shared Use Mobility Center (SUMC) and the Volpe National Transportation Systems Center, which provided very helpful context and information on similar AV projects across the United States.

Section 5

RAPID Project Conclusions and Recommendations

Conclusions and Recommendations

As a result of the Arlington RAPID project, the team can draw conclusions about key aspects of the demonstration and make recommendations that are hopefully applicable to other entities working on similar AV demonstration and integration projects. Key lessons learned and recommendations fall into the following categories:

- Ridership
- Operations
- Communications
- Research

Ridership

In the area of ridership, the project team studied ridership performance metrics, rider experience, and feedback directly from riders to develop lessons learned and recommendations. Ridership on the service was quite robust, with over 28,000 rides provided in the one-year demonstration, and riders expressed high levels of satisfaction with the service, averaging 4.9 out of 5 stars for the rider satisfaction rating. Rider experience metrics also denote good service, with on-time percentages at 99 percent to 100 percent and wait times averaging between 6 and 15 minutes. Riders also chose the AV rides at high rates, with average acceptance rates between 74 percent and 93 percent. Some of the likely reasons for the high number of rides taken on the service include the free fares for UTA students and the diversity of appealing destinations within the service area, including residential, school, work, and entertainment uses. Feedback from the riders in the form of surveys, interviews, and focus group discussions also illustrate why riders chose the RAPID service, including ease of booking and scheduling, reasonable price, comfortable rides, and feelings of safety. Riders also shared that if RAPID had shorter wait times and served a larger geographic area, they would have been even more likely to ride more frequently.

Based on the lessons learned about RAPID ridership, several recommendations have been developed by the project team:

- **Select the use case and demonstration area carefully.** AV services that operate as part of the public transportation system must have a range of clear uses for a variety of riders to ensure strong ridership. A density of population and diversity of uses within the AV service area will help drive

ridership and allow the AV service to meaningfully complement other modes of transportation.

- **Consider fare structure cautiously.** While standard fares did apply on the RAPID service, most of the ridership was driven by free rides taken by UTA students. The free ride was a significant incentive for riders and charging for the AV rides may have reduced ridership numbers overall.
- **Track rider experience metrics carefully to keep service consistent and efficient.** The project team tracked several rider experience metrics, including wait times, on-time performance, acceptance rate, and rider satisfaction throughout the demonstration to ensure the service was performing well for riders.
- **Gather feedback directly from riders throughout and use this to inform service.** Ridership surveys conducted throughout the length of the demonstration allowed the project team to monitor rider experience and adjust the service where necessary and possible.

Operations

With the complex operation of AVs integrated into an existing rideshare service for RAPID, there were many operational elements that the project team monitored and adjusted during the demonstration, including autonomy, integration, and software performance. By looking at both autonomy percentage for the overall service, which increased over the time of the demonstration, and by looking at autonomy heatmaps for the entire service area, the project team was able to target specific areas for modifications to improve autonomy, such as trimming vegetation, remapping areas under construction, and adjusting to pedestrian activity. Most integration work between the Via and May Mobility teams necessary to ensure seamless booking and dispatch of the AVs was in place before demonstration launch, but there were some adjustments that needed to be made during the demonstration to help the service function at a higher level. The Via and May Mobility teams worked closely together to communicate any issues and solve them in a way that worked for both platforms. Software updates rolled out by the May Mobility team also addressed operational elements, such as improving traffic light detection, predicting the path taken by other vehicles, and staying in automated mode at passenger stops. It was important to test these updates both internally with the May Mobility platform, as well as with the Via platform, to ensure all elements of the service operated smoothly after any software update.

Feedback from riders about operational elements was also received by the project team and used to adjust operations of the demonstration. Two frequent comments from riders centered around high levels of noise and heat, generated by the computers in the trunk of the vehicles, making the ride less comfortable for passengers. The project team was able to mitigate both issues during the demonstration, significantly improving the rider experience. Additionally, by

studying the ride request data, it was clear that there was much more rider demand in the later hours of the day, compared to early morning hours, leading to a shift in operating hours from 7 a.m. to 7 p.m. to operating hours from 8 a.m. to 8 p.m. part of the way through the demonstration.

Operational recommendations stemming from the RAPID demonstration include:

- **Set expectations regarding autonomy performance according to complexity of demonstration environment.** Most demonstration environments for public transportation will have at least some challenging areas or elements where the AV technology may be unable to perform at full autonomy. Being prepared for this reality and communicating to project partners and sponsors will help set reasonable expectations.
- **Maintain clear and constant communication between partners.** Weekly project team meetings for all partners allow the team to monitor performance closely and address any issues that arise. Subgroup meetings of the technical teams are also necessary to address integration adjustments and software updates.
- **Remain flexible to adjusting the service to meet the needs of riders.** Many aspects of a service can be changed, if necessary, even during a demonstration, to ensure that the needs of riders are being met and the service is providing the highest quality experience possible.

Communications

Lessons learned from the RAPID communication, outreach, and marketing efforts can be gleaned from efforts conducted prior to service launch and from ongoing communication efforts during demonstration. The pre-launch activities included brand creation, development of marketing materials and a service website, and a well-attended launch event with strong local and regional media coverage. The project team also conducted outreach to organizations within the service area, hosted focus groups with potential riders, and conducted first responder training. These activities helped build awareness of and excitement about the service before launch. Marketing materials, project website, and news stories about RAPID continued to be promoted and shared for the full course of the demonstration. However, it was revealed during post-demonstration interviews and focus group discussions that people were unaware of the service or did not fully understand all aspects of the service, even after all the outreach performed by the team. While the project team believes those who were reached by the communications efforts understood the service and were accepting of AV technology, it is clear that more could have been done to reach more people.

Based on lessons learned that relate to communication, the RAPID project team would suggest the following recommendations:

- **Pursue a variety of outreach methods.** Making use of a wide range of approaches to outreach and communication, including print, digital, and in-person events, will help reach a wider audience and provide the level of detail needed by different riders.
- **Continue outreach, education, and marketing activities before and during the entire demonstration to reach as many potential riders as possible.**
- **Be aware that it may be difficult to reach all potential users.** Even with a robust and on-going communications approach, knowledge of the RAPID service did not reach all potential riders. Awareness of the limitations of communication efforts is necessary to manage expectations around outreach goals for any public service.

Research

Activities related to research were an integral part of the RAPID project from start to finish. Research in preparation for the demonstration included a review of best practices literature, analysis of existing transportation services in Arlington, and talking to potential riders at focus groups. The findings from these research activities helped guide pre-launch preparations and allowed the project team to tailor the RAPID service, such as identifying service hours, likely pick-up and drop-off locations, and information to include in outreach and marketing campaigns. During the demonstration, the research team deployed two surveys to gather input from riders and non-riders alike on their thoughts about AV services. The feedback received in the surveys helped the project team understand the rider experience, learn about the demographics of RAPID riders, and gauge general feelings about AV technology and public transportation. Research activities included monthly analysis of survey results and service data, allowing the entire project team to track feedback and illuminate any issues with the service in real time. Finally, after the demonstration concluded, the research team performed analysis of the full dataset of survey results and service metrics to develop a robust picture of the RAPID service. Additionally, interviews and another focus group were conducted to gather qualitative and more detailed feedback from riders and non-riders than what could be collected through the survey instruments.

Several recommendations can be made based on the research approach for the RAPID project:

- **Base AV service design on research of existing conditions and needs in the demonstration area.** The research performed before and during demonstration of existing transportation services and the needs of

potential and active riders allowed the project team to tailor and adjust the service to meet the needs of as many potential riders as possible and improve the service for active riders.

- **Pursue research activities throughout the project, including before, during, and after demonstration.** Incorporating research through the project will result in helpful findings for the project itself and to share with others.
- **Include a range of different research approaches and methodologies to yield the most robust findings.** Qualitative and quantitative findings from the literature, ridership data, and rider feedback provided both numerical trends and rich details about the service, all of which was useful to design and operate the service effectively.

Next Steps

The RAPID demonstration is viewed by the City of Arlington and partners as a positive addition to the city's public transportation system, a valuable test of AV service in a complex environment, and a successful demonstration of how to integrate shared AV service into existing on-demand rideshare service. The City of Arlington hopes to make the RAPID service a permanent option for public transportation, and to that end, the project team began pursuing additional funding for RAPID during the FTA-funded demonstration. Just before the end of the planned RAPID demonstration in March 2022, the City was awarded $4.5 million in new funding from the North Central Texas Council of Governments (NCTCOG) to continue and expand the RAPID service. The NCTCOG funding will be used to operate RAPID for an additional two years and introduce new technology in the form of the vehicles and efforts to remove the human operator from the driver seat.

The new vehicles will be Toyota Sienna minivans developed especially for automated and ridesharing services. A portion of the Sienna fleet will be upfitted for riders using wheelchairs, allowing RAPID to serve all riders with the same vehicle type. Technologies related to removing the human operator will include installation of devices in the AVs and in first responder vehicles in the service area, which will allow first responder vehicles to communicate directly with the RAPID vehicles and give them instructions to respond appropriately to first responder vehicles. Tele-assist services, where a remote human operator is monitoring the RAPID vehicles and able to give the vehicles instructions in the event that the vehicle cannot make a decision on its own, are also planned to be tested during the next phase of the RAPID demonstration. As of the end of 2022, the City is working on securing the NCTCOG funding and all project partners are continuing to operate the RAPID service in anticipation of the next round of funding and next phase of the project.

The City of Arlington sincerely appreciates FTA's commitment to the development of automated technology as a viable component of public transportation in the United States and FTA's support of the Arlington RAPID project.

Appendix A RAPID Marketing Materials

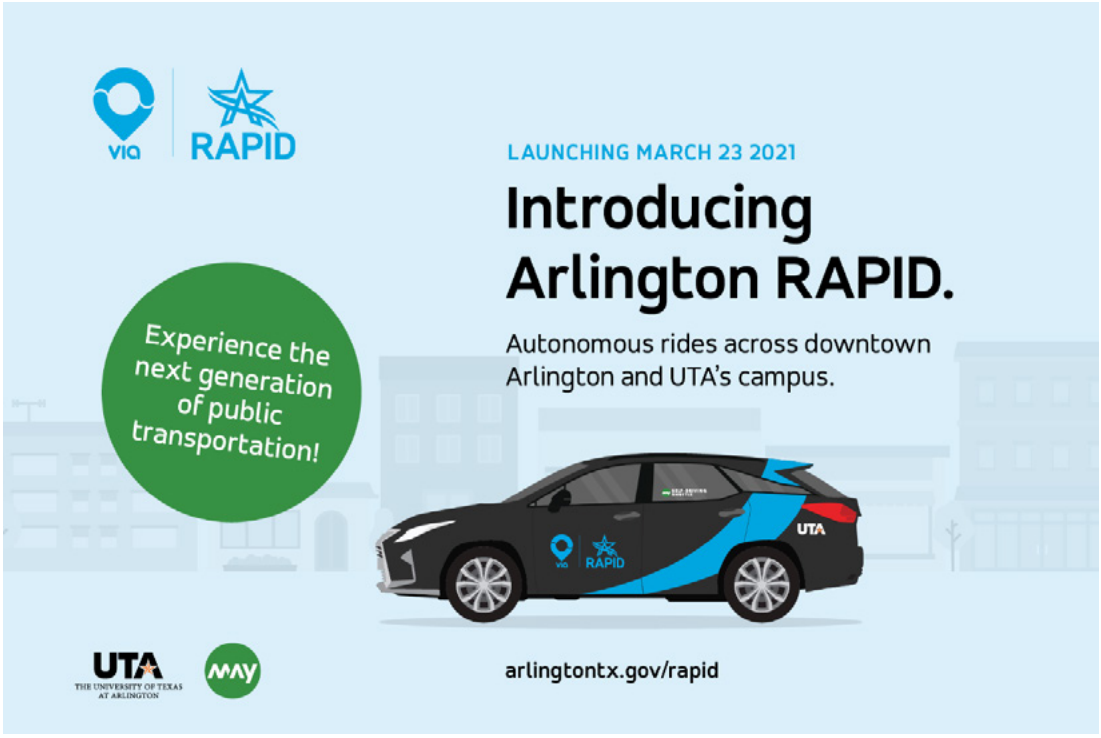

Figure A-1 *Front of Marketing Flyer*

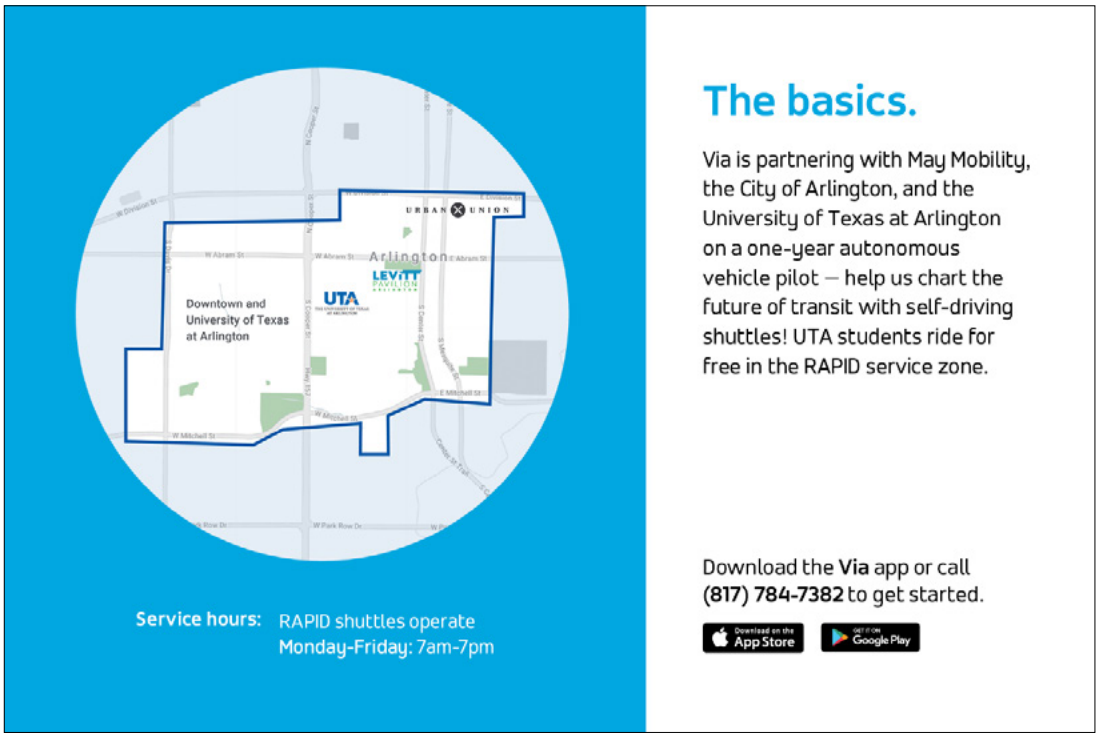

Figure A-2 *Back of Marketing Flyer*

Figure A-3 *Marketing Poster*

Figure A-4 *COVID-19 Safety Poster*

Figure A-5 *Social Media Marketing*

Appendix B Survey Instruments

Rider Survey

Dear Participant,

We are conducting a short, confidential survey to investigate your perceptions and attitudes towards the RAPID service area, the quality of the service, and the booking system. Your feedback would be valuable as you will be involved in improving the service quality of the RAPID project that will provide high-quality service to the City of Arlington. There are no perceived risks for participating in the study. There are no alternatives for this research project, but you may quit at any time. Any identifiable information will be kept confidential with access limited to the research team. For questions or concerns contact the UTA Research Office at 817-272-3723 or regulatoryservices@uta.edu. It will take about 5 to 10 minutes to participate in this research, and your participation is completely voluntary.

Thanks for riding Arlington's RAPID AV service! Please share your feedback with us through answering the following questions.

1. **What was the purpose of your trip on RAPID today?**

   ☐ Going to work

   ☐ Going to school

   ☐ Going shopping

   ☐ Going to a medical place

   ☐ Going to social and/or Recreational places

   ☐ Going to daycare/Childcare

   ☐ Returning home

   ☐ Others, please specify _____

2. **How long did you wait for the AV vehicle to arrive after requesting a ride?**

   ☐ Less than 5 minutes ☐ about 5- 10 minutes ☐ about 10-20 minutes

   ☐ about 20-30 minutes ☐ More than 30 minutes

3. Please share your opinion of your ride today.

	Strongly agree	Agree	Neutral	Disagree	Strongly disagree	Not applicable for this ride
Booking and scheduling my RAPID trip using the Via app was easy						
Booking and scheduling my RAPID trip through the call center was easy						
The price for riding RAPID was reasonable						
The waiting time was reasonable						
The pickup and drop off locations were convenient						
Boarding the vehicle was easy						
The seats in the vehicle were comfortable						
The climate control in the vehicle was appropriate						
The speed of the vehicle was reasonable						
I felt safe when riding RAPID						
I felt safe while sharing the vehicle on my RAPID ride with other passengers						
I would ride RAPID again in the future						

4. Which of the following transportation services have you used in the past? Select all that apply.

☐ Via ☐ Handitran ☐ Milo AV Pilot ☐ Drive.ai AV Pilot ☐ UTA Transportation

☐ Public transit in another city

☐ I haven't used public transit before

5. If you selected either the Milo or Drive.ai AV service in question 4, please tell us how your RAPID ride compared to the previous AV services through the following questions. If you did not select Milo or Drive.ai AV service in question 4, please skip question 5 and go to question 6.

	Much improved	Improved	No improvement	Worse	Much worse	I Don't know
Service area of RAPID						
Trip cost of RAPID						
Safety of riding on RAPID						
Convenience of trip with RAPID						
Waiting time on RAPID						
Travel time on RAPID						
Overall experience of riding RAPID						

6. What is your usual mode of transportation?

☐ Private vehicle ☐ Private app-based ride services, such as Uber or Lyft

☐ Via Service ☐ Handitran service ☐ UTA transportation

☐ Walking/biking ☐ RAPID service

☐ Other (Please specify) _____

7. How often have you ridden RAPID so far?

☐ This is my first time ☐ This is my second time ☐ About once per month

☐ About twice per month ☐ About once per week ☐ More than two times per week

8. What is your age group?

☐ 18-24 ☐ 25-34 ☐ 35-44 ☐ 45-54 ☐ 55-64 ☐ 65+

9. What is your home zip code? _____

10. What gender do you identify with?

☐ Female ☐ Male ☐ Other _____ ☐ Prefer not to answer

11. Are you currently a UTA student?

☐ Yes ☐ No

12. With which racial group do you most identify?

☐ American Indian or Alaska Native ☐ Asian ☐ Black or African American

☐ Native Hawaiian or Pacific Islander ☐ White ☐ Other _____

13. With which ethnicity group do you most identify?

☐ Hispanic ☐ Non-Hispanic

14. What was your household income last year?

☐ Less than $20,000 ☐ $20,000-$34,999 ☐ $35,000-$49,999 ☐ $50,000-$74,999

☐ $75,000-$99,999 ☐ $100,000 or more

15. How many vehicles are available to you and members of your household for daily travel?

_____ Vehicles

16. Do you have any further feedback for us to consider about our AV service?

_____

General Public Survey

Dear Participant,

We are writing to ask for your participation in a research survey at the **University of Texas at Arlington (UTA)**. This survey includes questions about your experiences using the **Arlington RAPID** autonomous vehicle (AV). The **Arlington RAPID** (Rideshare, Automation, and Payment Integration Demonstration) project is funded by the Federal Transit Administration (FTA) and integrates autonomous shuttles into the existing on-demand Via rideshare service that operates in Arlington. RAPID is a partnership between **FTA**, the **City of Arlington, UTA, Via Transportation**, and **May Mobility**. Your participation in the survey is voluntary, and your responses are completely confidential. You can choose to participate in this research study if you are at least 18 years old and over. This survey will take about **15 minutes**.

There are no perceived risks for participating in the survey, and you can quit the survey at any time you want. Your personal information will not be represented in the report or in any data available to the public. We will use your individual responses only for the purposes of this study. Thank you in advance for participating in this study. If you have any questions, I encourage you to contact **Dr. Sherri Kermanshachi** at shareareh.kermanshachi@uta.edu or **Dr. Jay Rosenberger** at jrosenbe@uta.edu. Thank you very much for your participation.

Part A: AV Usage and Perceptions

1. **Which statement best describes your status? (check ALL that apply).**

   ☐ I am 18 years or older

   ☐ I live, work, and/or study in Arlington

   ☐ None of the above (screen out)

2. **Please select the autonomous vehicle (AV) services that you have ridden in the City of Arlington (check ALL that apply).**

   ☐ RAPID ☐ Milo ☐ Drive.ai ☐ I have never used an autonomous vehicle in Arlington



3. **If you selected the RAPID option in question 2, please answer how many times you have ridden RAPID in Arlington. If you did not select the RAPID option in question 2, please skip questions 3-12 and go to question 13.**

One time	*Two times*	*Three to four times*	*Four to five times*	*More than five times*
☐	☐	☐	☐	☐

4. How do you usually access a RAPID pick-up point? (check the option that you use most often)

Pick Up from Home, school, or work location	*Walking or using a mobility device such as a wheelchair*	*Bicycle/ Scooter*	*Via Service*	*UTA Transportation Service*	*Handitran Service*	*Taxi/Uber /Lyft*	*Household vehicle (car/truck)*	*Other (please specify)*
☐	☐	☐	☐	☐	☐	☐	☐	☐

5. What is the typical purpose of your trips on RAPID? (check ALL that apply).

☐ Work

☐ School

☐ Shopping

☐ Medical

☐ Social and Recreational

☐ Others, please specify _____

6. After completing your trip on RAPID, do you usually use another transportation mode to reach your destination?

☐ Yes ☐ No

7. If yes, what transportation mode do you usually use after your RAPD ride to reach your destination?

Walking or using a mobility device such as a wheelchair	*Bicycle/ Scooter*	*Via Service*	*UTA Transportation Service*	*Handitran Service*	*Taxi/Uber /Lyft*	*Household vehicle (car/truck)*	*Other (please specify)*
☐	☐	☐	☐	☐	☐	☐	☐

8. Please rate your experience riding RAPID in the following areas by using a scale of 1 to 5 (1: very Poor, 2: Poor, 3: Average, 4: Good, 5: Excellent, 6: I do not know)

		Very Poor	Poor	Average	Good	Excellent	I don't know
		1	2	3	4	5	6
Trip time	Waiting time						
	In-vehicle travel time						
Trip cost	Ridership cost (reasonable trip fare)						
Service reliability & flexibility	Availability of RAPID at the time I need it						
	Access to accurate information about the RAPID service area, days, and hours of operation						
	Ease of payment through the RAPID app						
	Ease of booking process, trip planning and scheduling						
	Ease of boarding RAPID at the pickup and drop off locations						
Access	Access to desirable destinations						
Service capacity and quality	Adequate number of seats per vehicle						
	Comfort of seats and climate control						
Safety & security	Feeling of safety due to presence of onboard human attendant						
	Ride comfort due to the vehicle traveling at a reasonable speed						
	Feeling of safety about ability of the AV to interact with other vehicles on the road						
	Feeling of safety related to sharing the RAPID ride with other passengers						
	Feeling of comfort due to cleaning protocols while sharing the RAPID ride with other passengers						
Service Integration	Ability to book RAPID rides through call center						
	Ability to book Via ride and AV ride in the same app						

9. Do you have a disability that requires you to travel with a wheelchair or other type of assistance?

☐ Yes ☐ No

10. If yes, please rate your experience riding RAPID in the following areas by using a scale of 1 to 5 (1: very Poor, 2: Poor, 3: Average, 4: Good, 5: Excellent, 6: Not applicable)

		Very poor	Poor	Average	Good	Excellent	Not applicable
		1	2	3	4	5	6
Disability friendly	Availability of the wheelchair accessible vehicle at the time I need it						
	Ease of boarding RAPID for people with physical disabilities						
	Ability to request a ride on RAPID for people with visual impairments						

11. If you are a student at UTA, to what extent was the free ride for UTA students available on RAPID important in your decision to ride this service?

☐ Not at all important

☐ Of little importance

☐ Of average importance

☐ Very important

☐ Absolutely essential

☐ I am not a UTA student

12. Which statements describe the main reasons you rode the RAPID? (check ALL that apply).

☐ I rode RAPID to try the service

☐ I rode RAPID because UTA students get free AV rides

☐ I rode RAPID because I heard from others that they enjoyed their AV ride

☐ rode RAPID to accompany my friend/family on an AV ride

☐ I rode RAPID because it was the most convenient option for my trip

Part B: AV Users and Non-users' Preferences, Concerns and Attitudes

13. If you have not ridden RAPID yet, please answer which statements describe the main reasons for not riding RAPID? (check ALL that apply). If you have ridden RAPID skip this question and go to question 14.

☐ I did not know about RAPID

☐ RAPID did not provide service to my destinations

☐ RAPID did not provide service in the times that I needed a ride

☐ I did not feel safe riding RAPID

☐ I did not know how to book or pay for a ride

☐ I felt the RAPID service may not be as convenient as another mode of transportation

☐ Other reasons, please specify _____

14. Please rate your agreement with the following statements in the following areas by using a scale of 1 to 5 (1: Strongly disagree, 2: Disagree, 3: Neutral, 4: Agree, 5: Strongly agree, 6: I don't know)

		Strongly disagree	Disagree	Neutral	Agree	Strongly agree	I don't know
		1	2	3	4	5	6
Attitudes towards AV benefits	AVs can increase the convenience of travel						
	AVs can make my trips easier since I will no longer need to look for parking						
Attitudes towards AV safety	Cyber security is a concern						
	Confusion among human drivers and AVs on the streets is probable						
	AVs can make transportation safer						
	I would recommend AVs to my family and friends						
	I support AV technology						
	I prefer riding an AV to driving myself						

15. If the RAPID service continues to provide rides in Arlington, how likely would you be to ride the service?

☐ Very unlikely

☐ Somewhat unlikely

☐ Neither unlikely nor likely

☐ Somewhat likely

☐ Very likely

16. According to your answer to question 15, please tell us what factors affect your response to question 15?

_____

_____

Part C: Respondents' Travel Patterns

17. How often do you usually use the following modes of transport?

	Never	Less than once per month	Once per month	Two to three times per month	Once per week	Two or three times per week	More than three times per week
Car							
Via rideshare service							
Private app-based services such as Uber/ Lyft							
Handitran service							
UTA transportation services							
Walking/biking							
Trinity Railway Express							

Part D: Respondents' Residential Location

18. Please provide the following information about your home, work, or school locations. Please choose the one most commonly visited location in a typical week)

Home zip code	Work zip code	School zip code
_____	_____	_____
	☐ Not applicable	☐ Not applicable

19. Please indicate the approximate driving distance (in minutes) from your current residence to different errands (by car):

(perceived accessibility)	Less than 5 minutes	5-10 minutes	10-15 minutes	15-20 minutes	More than 20 minutes
Closest grocery store or department store (such as Walmart or Target)					
Closest shopping mall					
Closest restaurant or fast-food place					
Closest drugstore					
Closest health care provider					
Closest place to exercise (e.g., a gym or a park)					

Part E: Respondents' Background

20. What gender do you identify with?

☐ Male

☐ Female

☐ Other/Nonbinary

☐ Prefer to not answer

21. Please indicate your age group from the below list.

☐ 18-24 ☐ 25-34 ☐ 35-44 ☐ 45-54 ☐ 55-64 ☐ 65+

22. With which racial group do you most identify?

☐ American Indian or Alaska Native

☐ Asian

☐ Black or African American

☐ Native Hawaiian or Pacific Islander

☐ White

☐ Other _____

23. With which ethnicity group do you most identify?

☐ Hispanic ☐ Non-Hispanic

24. What is your educational background? Please check the highest level attained.

- ☐ Prefer not to answer
- ☐ Some grade/high school
- ☐ High school/GED
- ☐ Some college/technical school
- ☐ Associate's degree
- ☐ Bachelor's degree
- ☐ Graduate or professional degree (e.g. MS, PhD, MBA, JD, MD, DDS, etc.)

25. Which statement best describes your current employment? (check ALL that apply).

- ☐ I work full-time
- ☐ I work part-time
- ☐ I am a student
- ☐ I am a homemaker/unpaid caregiver
- ☐ I currently do not work/I am retired/looking for work

26. What statement best describe your current working or studying status?

- ☐ I fully work/study from home
- ☐ I partially work/study from home
- ☐ I fully work/study from my work/school place

27. What was your household income last year?

- ☐ Less than $20,000
- ☐ $20,000-$34,999
- ☐ $35,000-$49,999
- ☐ $50,000-$74,999
- ☐ $75,000-$99,999
- ☐ $100,000 or more

28. Do you have a valid driver's license?

☐ Yes ☐ No

29. How many vehicles are available to you and members of your household for daily travel?

_____ Vehicles

30. Do you have any of the following long-lasting conditions?

(a) Blindness, deafness, or a vision or hearing impairment?

☐ Yes ☐ No

(b) A condition that substantially limits one or more physical activities such as walking, climbing stairs, reaching, lifting, or carrying?

☐ Yes ☐ No

31. What assistance, if any, do you need to board public transit?

☐ Ramp ☐ Patient Care Assistant (PCA)

☐ Lift ☐ Service animal

☐ Others, please specify _____

☐ None

32. Do you have any further thoughts to share with us about RAPID?

_____

_____

_____

_____

U.S. Department of Transportation
Federal Transit Administration

U.S. Department of Transportation
Federal Transit Administration
East Building
1200 New Jersey Avenue, SE
Washington, DC 20590
https://www.transit.dot.gov/about/research-innovation