

Current AV Deployment & Shuttle Initiatives in the United States

Synthesis of Agency Experiences
and Lessons Learned

A JOINT EFFORT OF THE

CTSO Cooperative Automated Transportation
& CAT Coalition Infrastructure-Industry (I-I)
Working Groups

June 2020

Disclaimer

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1.0 Summary

A key goal of the CAT Coalition's Infrastructure-Industry Working Group was to understand the current status of autonomous vehicle (AV) shuttle deployments that are operating in the United States, and the associated experiences and lessons learned by state and local departments of transportation (DOTs). This document presents the results of the survey conducted to learn more about AV shuttle deployments and experiences in the United States to date.

The survey covers a wide variety of topics related to AV shuttle deployments, many with open-ended responses. Note that not all respondents answered every survey question, as reflected in the sections below. Highlights of the survey results include the following observations:

- Out of 34 respondents, 84 percent answered affirmatively that AVs have been tested or deployed in their region.
- Respondents were asked about the top three critical success factors for AV shuttle deployments. Recurring responses among the 13 respondents included: safety; coordination, collaboration, or partnership; public engagement and acceptance; and the need to test new systems and technologies to improve them.
- Out of the 10 respondents, five already have established direct communications between the AV and infrastructure and two more respondents have plans to do so. Direct communications cited include dedicated short-range communications (DSRC), cellular V2X (C-V2X), or other vehicle-based technologies.
- Most respondents (7 of 11) indicated that special authorizations have not been required from the Department of Motor Vehicles (DMV) or other local or state agencies. Three respondents noted coordination to obtain licenses or registration, and a fourth respondent noted a permit process that was followed for the AV shuttle deployment.
- Nine survey respondents provided information on data being collected by the AV shuttle deployments. The most common data collected and provided to agencies is ridership (6) and rider satisfaction / public acceptance (4) data. Video (3) and data on unexpected events (3) like trip cancellations and emergency stops were other recurring responses. However, several respondents noted data collected by the shuttle operator that was not available or provided to the agency.
- Respondents provided a variety of lessons learned. Common themes noted public acceptance and enthusiasm for AV deployments, the need to involve emergency responders or other partners, the importance of the relationship between agency and vendor, validation of technology and specific issues, and cost considerations.
- Regarding next steps, two respondents described additional deployments or new phases of testing that are planned, two respondents have no plans yet, and most respondents (6) are seeking new opportunities or funding to pursue additional, related activities.

The following sections include all survey questions and detailed information identifying the responding agencies and their responses.

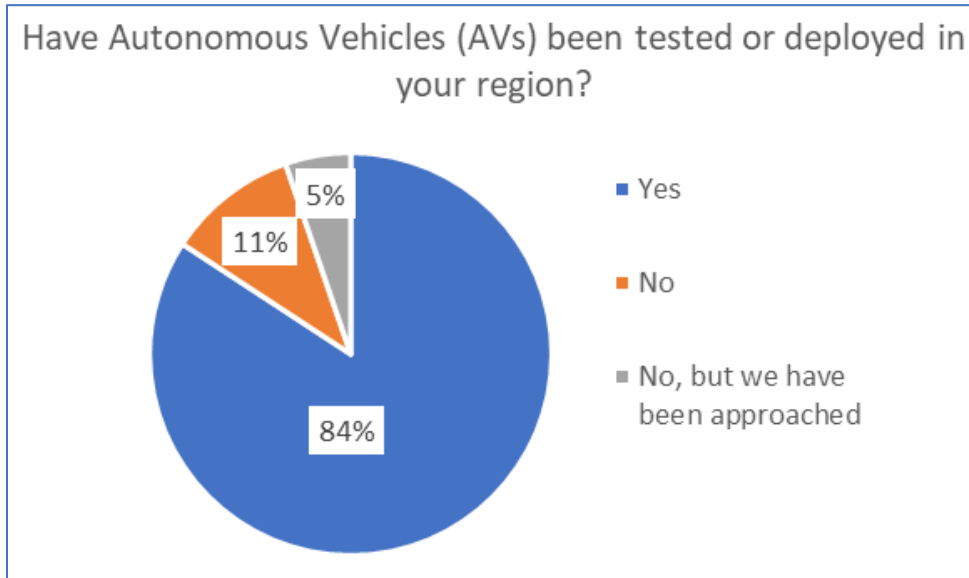
2.0 Survey Responses

In total, a total of 38 survey responses were received from 30 State and 8 Local Agency Staff, representing 26 state agencies and 8 local agencies in 22 states and the District of Columbia.

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3.0 Have Autonomous Vehicles (AVs) been tested or deployed in your region?



State	Agency	Yes	No	No, but we have been approached
AK	Alaska DOT&PF		1	
AZ	Arizona DOT	1		
AZ	Arizona DOT	1		
CA	California DMV	1		
CA	Caltrans	1		
DC	District DOT	1		
DE	Delaware Transit Corporation	1		
FL	City of Gainesville RTS	1		
FL	Florida DOT	1		
GA	Georgia DOT	1		
IA	Iowa DOT	1		
KY	Kentucky Transportation Cabinet			1
MD	Maryland DOT MVA	1		
MD	Maryland DOT State Highway Administration	1		
MD	Maryland Transportation Authority	1		
MI	Michigan DOT	1		
MN	Minnesota DOT	1		
MN	Minnesota DOT	1		
MO	Missouri DOT	1		
NJ	New Jersey DOT			1
NV	City of Las Vegas	1		
NV	Nevada DOT	1		
NV	RTC of Southern Nevada	1		
OH	DriveOhio	1		

State	Agency	Yes	No	No, but we have been approached
PA	Pennsylvania DOT	1		
SC	South Carolina DOT		1	
TX	City of Arlington	1		
TX	City of Austin Transportation Department	1		
TX	City of Frisco	1		
TX	Metropolitan Transit Authority of Harris County	1		
TX	North Central Texas Council of Governments	1		
TX	Texas DOT	1		
TX	Texas DOT	1		
UT	Utah DOT	1		
VA	Virginia DOT	1		
WA	Washington State DOT	1		
WY	Wyoming DOT		1	
WY	Wyoming DOT		1	
	Total	34	4	2

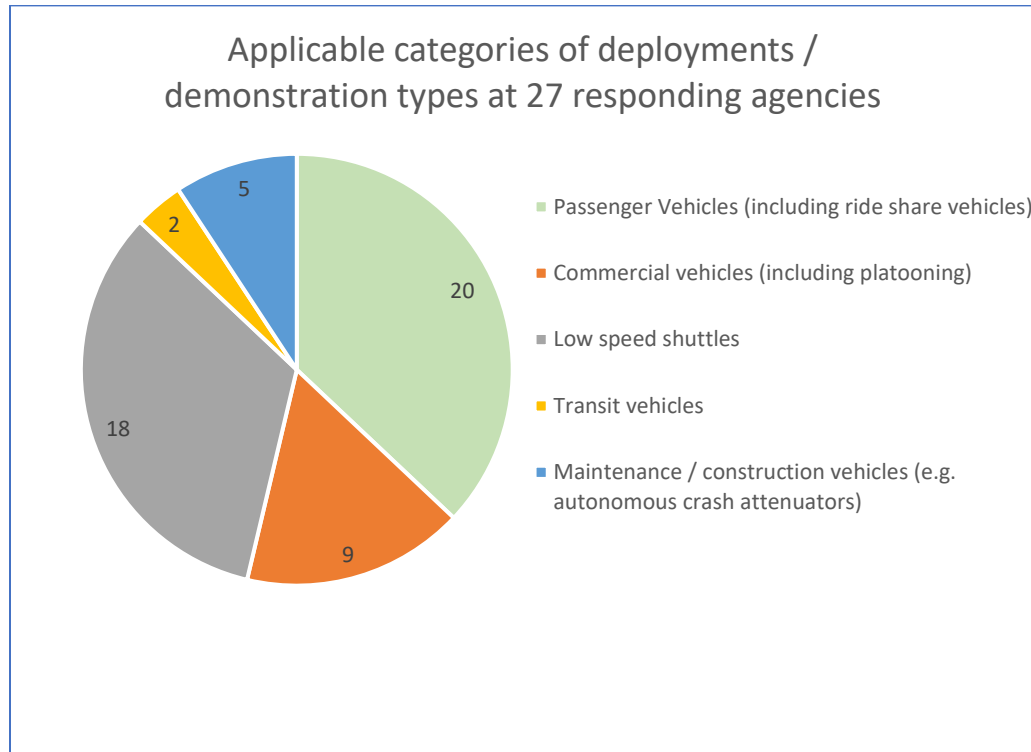
4.0 AV Vendors (OEMs, Suppliers, AI Companies, etc.) operating or testing in your region

State	Agency	AV Shuttles	OEMs/Suppliers/AI Companies	Others
AZ	Arizona DOT			Waymo
AZ	Arizona DOT		Waymo, Uber, TU Simple, Nikola	
CA	California DMV			64 companies are authorized to test in California, listed at: www.dmv.ca.gov
DC	District DOT		Ford	Uber
DE	Delaware Transit Corporation	EasyMile		
FL	City of Gainesville RTS	Transdev	EasyMile	
FL	Florida DOT	Easy Mile in Gainesville by RTS		
IA	Iowa DOT			National Advanced Driving Simulator - University of Iowa
MD	Maryland DOT MVA	Local Motors, Easy Mile	Local Motors, Robotics Research, STEER Tech,	Westat, Leidos, Argo AI, NuTech
MD	Maryland DOT State Highway Administration	Olli	STEER	Please note some companies have confidentiality requests
MD	Maryland Transportation Authority	Local Motors, Robotics Research	SteerTech	
MN	Minnesota DOT	EasyMile	Plus.AI; Polaris Industries; 3M; Iteris; HERE; Kratos Defense; VSI Labs	Applied Intelligence; Traffic Control Corporation
MO	Missouri DOT			Autonomous TMA
NJ	New Jersey DOT			
NV	City of Las Vegas	Navya arma	Aptiv	
NV	Nevada DOT		Aptiv. WayCare Cisco	
NV	RTC of Southern Nevada	Navya	Aptiv	Commsignia, Trafficast, Qualcomm

State	Agency	AV Shuttles	OEMs/Suppliers/AI Companies	Others
OH	DriveOhio	May Moblity, EasyMile	Honda, Plus.ai	
PA	Pennsylvania DOT		Aptiv, Argo AI, Aurora, Locomation, Plus.AI, Uber, Qualcomm	Carnegie Mellon University
TX	City of Arlington	EasyMile, Drive.ai		
TX	City of Frisco	drive.ai		Fedex
TX	Metropolitan Transit Authority of Harris County	EasyMile		First Transit
TX	North Central Texas Council of Governments	EasyMile	Drive.ai; Kodiak Robotics; Starsky Robotics; TuSimple; iSee	
TX	Texas DOT	EasyMile, Drive.AI	Ford, Argo AI, Uber, Waymo, Cruise, Embark, Kodiak, TuSimple, ISEE, Ike, Daimler, Aurora, Locomation, Peloton, Eject	Nuro, Udelv, Marble
UT	Utah DOT	EasyMile	A couple of companies have "driven" their vehicles across the state.	Peloton has done some demonstrations here
VA	Virginia DOT	EasyMile, Perone, Local Motors	Daimler	FHWA - CARMA, VTTI
WA	Washington State DOT		Drivent LLC Dooblai LLC Galilei Github Inc. LM Industries Group, Inc. May Mobility Micro Systems, Inc. Navya Inc NVIDIA Corporation PACCAR Inc. Peloton Technology, Inc. Simple Solutions TORC Robotics Waymo LLC Zoox, Inc.	Summary of a voluntary survey conducted of all registered companies in WA
	Total	17	17	16

5.0 Applicable categories of deployments / demonstration types

5.1 Active deployments / demonstration types



State	Agency	Passenger Vehicles (including ride share vehicles)	Commercial vehicles (including platooning)	Low speed shuttles	Transit vehicles	Maintenance / construction vehicles (e.g. autonomous crash attenuators)	Other (please specify)
AZ	Arizona DOT	1					
AZ	Arizona DOT	1	1	1			
CA	California DMV	1					
DC	District DOT	1					
DE	Delaware Transit Corporation			1			
FL	City of Gainesville RTS			1	1		
FL	Florida DOT				1		
IA	Iowa DOT	1					Transit vehicle deployment and related research in development as part of an ADS grant the NADS group applied for and won
MD	Maryland DOT MVA	1		1			smart bus stops
MD	Maryland DOT State Highway Administration	1		1			
MD	Maryland Transportation Authority	1		1		1	
MN	Minnesota DOT	1	1	1		1	
MO	Missouri DOT					1	
NJ	New Jersey DOT						
NV	City of Las Vegas	1		1			
NV	Nevada DOT	1	1				
NV	RTC of Southern Nevada	1		1			
OH	DriveOhio	1		1			
PA	Pennsylvania DOT	1	1			1	
TX	City of Arlington	1		1			
TX	City of Frisco			1			Personal delivery units
TX	Metropolitan Transit Authority of Harris County			1			

State	Agency	Passenger Vehicles (including ride share vehicles)	Commercial vehicles (including platooning)	Low speed shuttles	Transit vehicles	Maintenance / construction vehicles (e.g. autonomous crash attenuators)	Other (please specify)
TX	North Central Texas Council of Governments	1	1	1			
TX	Texas DOT	1	1	1			
UT	Utah DOT	1	1	1			
VA	Virginia DOT	1	1	1		1	
WA	Washington State DOT		1				Report on platooning prepared for WA AV WG Infrastructure and Systems Subcommittee
Total		20	9	18	2	5	

5.2 If approached, applicable deployments/demonstration types that approached your agency

State	Agency	Passenger Vehicles (including ride share vehicles)	Commercial vehicles (including platooning)	Low speed shuttles	Transit vehicles	Maintenance / construction vehicles (e.g. autonomous crash attenuators)	Other (please specify)
KY	Kentucky Transportation Cabinet		1		1		
NJ	New Jersey DOT			1	1	1	

6.0 Top 3 critical success factors for AV shuttle deployment

State	Agency	#1	#2	#3
FL	City of Gainesville RTS	Ability to transport passengers (testing)	Connected Vehicle (V2I, V2V) (will test)	Bike/Pedestrian detection (testing)
MD	Maryland DOT MVA	safety	reliability	ease of use / acceptance of use
MD	Maryland DOT State Highway Administration	Building up the ODD slowly for the shuttle the practice and find all gaps a human normally fills in naturally	Constant and clear directions to the public (trust factor)	legal agreements allowing the DOT or owners to protect the public from vendors
MN	Minnesota DOT	NHTSA coordination	Traffic signal connection (DSRC/C-V2X)	Communications, risk and emergency management
NJ	New Jersey DOT	Safety		
NV	City of Las Vegas	Ridership	Public acceptance	Reliability
NV	RTC of Southern Nevada	Safety	Learning about AV deployments	Customer exposure to AV
TX	City of Arlington	Commitment/Organization of vendor	City staff capacity	political support
TX	City of Frisco	Low wait times (headway)	Ridership	Low cost (fares)
TX	Metropolitan Transit Authority of Harris County	Strong Planning Process	Partnership & Collaboration with Key Partners	Good vendor
TX	Texas DOT	Collaboration with first responders, TMCs, businesses and local leaders	Constant public engagement and education, before/during/after, including surveys and performance metrics	Clear objectives, coordinated use cases
UT	Utah DOT	To make them practical, we need to remove the operator	Systems need to be improved so they will navigate around an obstacle	Clearly, they need to operate safely.
VA	Virginia DOT	Detailed planning - infrastructure needs, traffic flow, public engagement, etc.	Coordination between all stakeholders - law enforcement, businesses along the route, state agencies, etc.	Identification of deployment goal - research versus transit use case versus public engagement etc.

7.0 Leading use cases (problems to solve) inspiring Shuttle AV deployment

State	Agency	Use Case #1	Use Case #2	Use Case #3
FL	City of Gainesville RTS	Federal Compliance (ADA compliance, Buy America, etc.)	NHTSA waiver approval	Policy development to operate regularly
MD	Maryland DOT State Highway Administration	large parking area: shuttle employees or clients from one end of the lot to entry points	high commercial density to promote transit and short distance mobility to those who do not wish to or cannot walk	transportation to mobility-limited communities that have little to no access to transit options
MN	Minnesota DOT	Winter/inclement weather	Pedestrian/vulnerable road user safety	Equity, access and mobility for all
NV	City of Las Vegas	Downtown circulation	Transition from single occupant drivers to high capacity vehicles	Roadway safety and operational efficiencies
NV	RTC of Southern Nevada	Learning what's involved with a deployment	first mile last mile	public awareness
TX	City of Arlington	public transportation	circulator service	
TX	City of Frisco	Transportation from complimentary uses (office to restaurant)	Length of time to drive and park or walk was too long	Exposure of citizens to new technology
TX	Metropolitan Transit Authority of Harris County	How safe is the technology	Public Adoption & Use for First and Last Mile	Integration with Public Transit
TX	Texas DOT	Campus in and around	Medical center movement	Entertainment districts, and combined use business/living/entertainment
UT	Utah DOT	Wanted to see if they could be used successfully in a transit network - filling the first-mile / last-mile gap	Needed to understand the operating parameters - battery life, maintenance challenges, etc	Engage the public and get their feedback; the public doesn't trust AV systems, but they have never experienced them.
VA	Virginia DOT	Planning for something so new/never done before	Coordinating all of the necessary stakeholders	Figuring out appropriate signage, descriptions, etc.

8.0 How was/were your use case(s) developed or sourced?

State	Agency	Response
MD	Maryland DOT State Highway Administration	by the vendors, with input from the DOT - the deployments in MD are all vendor owned (not purchased or leased by the DOT).
MN	Minnesota DOT	Workshops with communities
NV	City of Las Vegas	City priorities
NV	RTC of Southern Nevada	collaboration with public sector partners and private sector partners
TX	City of Arlington	Based on practical feasibility
TX	City of Frisco	With input from Transportation Management Association
TX	Metropolitan Transit Authority of Harris County	Through Team Houston
TX	Texas DOT	Developed through community surveys, refinement of user stories, design thinking to reach complete business cases, and then sharing with industry for potential solutions. Sourced through local funding.
UT	Utah DOT	We operated the shuttle in a number of locations with different demographics - shopping center, university campus, office park, convention center, etc. Most of these locations had a transit component; we were "connecting" to a light rail or commuter rail hub. We surveyed the public with a tablet and with some more extensive methods.
VA	Virginia DOT	VDOT acts as a supporting stakeholder for a county/utility partnership to deploy an automated shuttle with a grant from our Department of Rail and Public Transportation

9.0 Shuttle Operations Most Often Occur in Mixed Traffic

State	Agency	Dedicated Lane	Mixed Traffic	Closed Environment	Other
FL	City of Gainesville RTS		1		
MD	Maryland DOT MVA		1		
MD	Maryland DOT State Highway Administration		1	1	
MN	Minnesota DOT	1	1	1	All of the above; first in a closed environment, then dedicated lane, then mixed traffic
NV	City of Las Vegas		1		
NV	RTC of Southern Nevada		1		
TX	City of Arlington		1	1	
TX	City of Frisco		1		
TX	Metropolitan Transit Authority of Harris County			1	University Campus along pedestrian walkway
TX	Texas DOT		1		
UT	Utah DOT		1	1	We deployed in a variety of scenarios. Sometimes it was on a walking path, other times with mixed traffic on a low-volume road or in a parking lot.
VA	Virginia DOT		1		Deployment still in the planning stages, likely to run later this year

10.0 Project Partners involved with the deployment

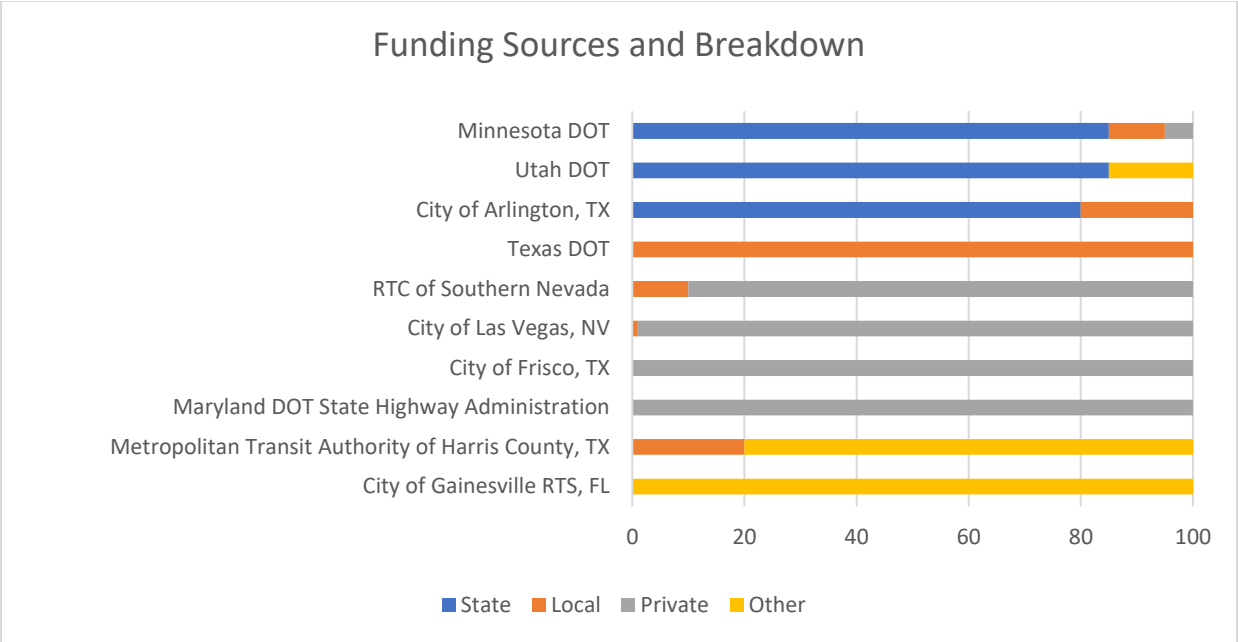
State	Agency	Lead Agency	Supporting Agencies or Partners	Vehicle Make/Model	Service Operator	Technology Company (Developer of AV Technology)
FL	City of Gainesville RTS	City of Gainesville Regional Transit System (RTS)	University of Florida (UF), FDOT	EasyMile Gen 2	Transdev	EasyMile
MN	Minnesota DOT	DOT	Transit agency, local city, adjacent businesses, local economic development agency	EasyMile Gen2	First Transit	
NV	City of Las Vegas	City of Las Vegas	RTC of Southern Nevada; AAA; Keolis	Navya arma	Keolis	Navya arma
NV	RTC of Southern Nevada	City of Las Vegas	Clark County, Regional Transportation Commission, Nevada DOT	Navya, BMW, other	aptiv, Keolis	aptiv, navya
TX	City of Arlington	City of Arlington		EasyMile 1st gen shuttle, Drive.ai Nissan NV200	EasyMile - First Transit, Drive.ai - Drive.ai	EasyMile, Drive.ai
TX	City of Frisco	Frisco Transportation Management Association	City of Frisco, Denton County Transportation Authority, Hall Group, Blue Star, Hillwood	Nissan NV200	Drive.ai	Drive.ai
TX	Metropolitan Transit Authority of Harris County	Metropolitan Transit Authority Harris County (Houston METRO)	Texas Southern University/City of Houston/Houston Galveston Area Council/	EasyMile Gen 2	First Transit	EasyMile
TX	Texas DOT	Frisco and Arlington transportation departments, Texas State University, Texas A&M	Police, Fire, traffic management centers, TxDOT, local governments, Dallas Cowboys Star complex and AT&T stadium, Drive AI, EasyMile	Low speed AV shuttle (EasyMile); or van (Drive.AI)	Lead Agency	EasyMile, Drive.AI

State	Agency	Lead Agency	Supporting Agencies or Partners	Vehicle Make/Model	Service Operator	Technology Company (Developer of AV Technology)
UT	Utah DOT	Utah Dept of Transportation	Utah Transit Authority	EasyMile EZ10 - Gen 2	EasyMile provided two operators (their employees)	EasyMile
VA	Virginia DOT	Fairfax County	Dominion (utility company), Virginia DRPT, VDOT	Version 3.0	Contract details still being finalized	EasyMile

11.0 Shuttle AV deployment ADA Accessibility (i.e. wheelchair accessibility, braille, audio announcements, etc.)

State	Agency	Response
FL	City of Gainesville RTS	Dealing with this issue as part of the project
MN	Minnesota DOT	It has audio and a wheelchair ramp
NV	City of Las Vegas	Since it was privately funded and pilot, the vehicles did not have ADA ramps.
NV	RTC of Southern Nevada	not sure
TX	City of Arlington	EasyMile shuttle had a wheelchair ramp, Drive.ai was not ADA accessible
TX	City of Frisco	None
TX	Metropolitan Transit Authority of Harris County	The EasyMile Gen 2 is not ADA compliant but is wheelchair accessible. An on-board attendant is available to assist. The are stops are at curb cuts in order to facilitate ADA usage.
TX	Texas DOT	EasyMile Deployments took that into account and ADA Accessibility was one of the objectives of the pilots.
UT	Utah DOT	It has a wheelchair ramp, braille buttons to deploy it, audio announcements (not always used) and some relatively rudimentary wheelchair tie-down systems.
VA	Virginia DOT	I have heard discussions about how the wheelchair ramp will work, but do not have more details. The shuttle is in Virginia but due to COVID-19, many stakeholders have not been able to view it in-person yet.

12.0 Funding for the Shuttle AV pilot deployment



12.1 Funding sources

State	Agency	Federal	State	Local	Private	Other
FL	City of Gainesville RTS					FDOT funds
MD	Maryland DOT State Highway Administration				1	
MN	Minnesota DOT		1	1	1	
NV	City of Las Vegas				1	
NV	RTC of Southern Nevada			1	1	
TX	City of Arlington		1	1		
TX	City of Frisco					No cost pilot
TX	Metropolitan Transit Authority of Harris County			1		Houston METRO & City of Houston
TX	Texas DOT			1		
UT	Utah DOT		1			Utah Transit Authority (not a state agency) used some of their funds
VA	Virginia DOT		1	1	1	

12.2 Percentage breakdown of funding per source

State	Agency	Federal	State	Local	Private	Other
FL	City of Gainesville RTS	0	0	0	0	100
MD	Maryland DOT State Highway Administration	0	0	0	100	0
MN	Minnesota DOT	0	85	10	5	0
NV	City of Las Vegas	0	0	1	99	0
NV	RTC of Southern Nevada	0	0	10	90	0
TX	City of Arlington	0	80	20	0	0
TX	Metropolitan Transit Authority of Harris County	0	0	20	0	80
TX	Texas DOT	0	0	100	0	0
UT	Utah DOT	0	85	0	0	15

13.0 Shuttle AV pilot deployment route navigating intersections

13.1 All Shuttle AV pilot deployment routes surveyed navigate signalized, stop controlled, or uncontrolled intersections

State	Agency	Response
FL	City of Gainesville RTS	Yes
MD	Maryland DOT State Highway Administration	Yes
MN	Minnesota DOT	Yes
NV	City of Las Vegas	Yes
NV	RTC of Southern Nevada	Yes
TX	City of Arlington	Yes
TX	City of Frisco	Yes
TX	Metropolitan Transit Authority of Harris County	Yes
TX	Texas DOT	Yes
UT	Utah DOT	Yes
VA	Virginia DOT	Yes

13.2 How is the movement being coordinated?

State	Agency	Response
FL	City of Gainesville RTS	Part of the next phase testing Connected vehicle technology
MD	Maryland DOT State Highway Administration	vision on vehicles
MN	Minnesota DOT	The DOT is leading coordination with the transit agency, shuttle provider, state public safety, traffic engineers and NHTSA. Now we're also having to navigate the new FCC ruling.
NV	City of Las Vegas	DSRC communication
NV	RTC of Southern Nevada	DSRC, other vehicle-based technology
TX	City of Frisco	Cameras with supervision from tele-ops. AV can detect signal color at signalized intersections. Waits for gaps in traffic at stop-controlled intersections
TX	Metropolitan Transit Authority of Harris County	Movement is coordinated by mapping
TX	Texas DOT	All stakeholders did tabletop exercises of use cases, emergency scenarios and traffic management. Vehicles operated then independently, they weren't tracked every second other than maybe by the AV company.
UT	Utah DOT	At the stop controlled intersections, the shuttle is programmed to stop there, and uses it's sensors to determine when it is safe to cross (no other traffic). We have one test environment where we are using DSRC V2I communication to allow the shuttle to know when the traffic signal is green.
VA	Virginia DOT	TSP, SPaT broadcasts from RSUs

14.0 Communications between the AV and infrastructure

14.1 Direct communications established between the AV and infrastructure

State	Agency	Response
FL	City of Gainesville RTS	Same answer as before
MD	Maryland DOT State Highway Administration	not yet but soon to be
MN	Minnesota DOT	Yes. We are upgrading DSRC to C-V2X signal units.
NV	City of Las Vegas	Yes via DSRC
NV	RTC of Southern Nevada	yes
TX	City of Frisco	No
TX	Metropolitan Transit Authority of Harris County	No
TX	Texas DOT	No, no connected activities
UT	Utah DOT	In one test environment (not one of the public deployments), we used DSRC V2I to communicate with a signal.
VA	Virginia DOT	See previous answer

14.2 Other than Roadside Unit (RSU) installations, were there any roadway, communication or technology deployments to support operations?

State	Agency	Response
FL	City of Gainesville RTS	Not roadside but On board Units will be installed
MN	Minnesota DOT	Not permanent; only temporary traffic control
NV	City of Las Vegas	GPS and cellular boosters
NV	RTC of Southern Nevada	no
TX	City of Arlington	none
TX	City of Frisco	No
TX	Metropolitan Transit Authority of Harris County	No
TX	Texas DOT	There were designated pick-up points for the Drive.AI deployments, as well as user software for scheduling rides.
UT	Utah DOT	Just a DSRC RSU.
VA	Virginia DOT	Yes, TSP.

15.0 Route and maneuvers performed (i.e. left turns, yield at pedestrian crossings), and did the service actively pickup and drop off passengers?

State	Agency	Response
FL	City of Gainesville RTS	Testing on regular traffic conditions (e.g., roundabouts, stop signs, traffic lights). Left turn testing in future phases
MN	Minnesota DOT	Yes; All of the above. More detailed route information can be shared by email.
NV	City of Las Vegas	There were 3 pick up stations; over 30,000 people rode the shuttle in 10 month period; the route was a clockwise right turn loop; length was 0.6 miles.
NV	RTC of Southern Nevada	All maneuvers of a normal vehicle and active pick-up and drop-off
TX	City of Arlington	EasyMile - Pedestrian trail out and back route. Did actively pick up and drop off passengers. Drive.ai - circular route covering several blocks, all left turns, actively picking up and dropping off passengers.
TX	City of Frisco	The route was approximately one mile and included public streets and private drives and parking lots. The route included one signal and several stop controlled intersections. Some required crossing multi-lane roads, some left turns, and a roundabout. The service actively picked up and dropped off passengers at designated points.
TX	Metropolitan Transit Authority of Harris County	It is a straight route with yield at bike trail. Yes it picked up and dropped passengers.
TX	Texas DOT	Drive.AI deployments in Frisco and Arlington were significantly large routes running through multiple intersections with lights and stop signs, and moving between stadium facilities and hotels (Arlington) or between businesses and the Star entertainment complex (Frisco). EasyMile routes have been more limited to an up and back route, or circle. They are in much more close proximity to pedestrians. All services actively picked up and dropped off at multiple points.
UT	Utah DOT	Again, we had various different sites. However, the shuttle did make left turns, but not at controlled stop signs (this was within parking lots). It did yield to ped crossings in numerous places (cross-walks), it moved through stop-controlled intersections (no turns here), and did actively pick-up and drop off passengers.
VA	Virginia DOT	The shuttle has yet to run.

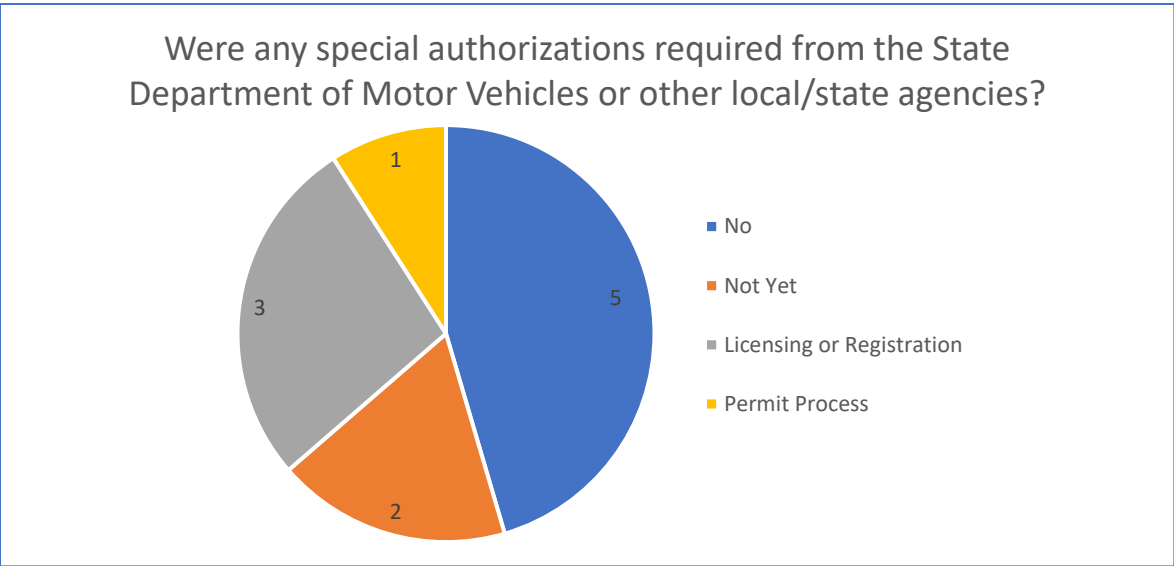
16.0 Timeline for the Operator to obtain the Waiver for the Shuttle AV pilot from the National Highway Traffic Safety Administration (NHTSA)

State	Agency	Response
FL	City of Gainesville RTS	More than 6 months
MN	Minnesota DOT	3 to 6 months
NV	City of Las Vegas	More than 6 months
NV	RTC of Southern Nevada	More than 6 months
TX	City of Arlington	Less than 3 months
TX	Metropolitan Transit Authority of Harris County	Less than 3 months
TX	Texas DOT	3 to 6 months
UT	Utah DOT	Less than 3 months
VA	Virginia DOT	More than 6 months

17.0 Lessons learned to help with the Waiver process

State	Agency	Response
FL	City of Gainesville RTS	Painful and long process, without clear guidelines to obtain the waiver
MN	Minnesota DOT	Start earlier than you ever anticipated, be strategic in how you draft the waiver to provide just enough information to address safety, but not so much as to create any concerns.
NV	City of Las Vegas	No known lessons learned other than start early!
NV	RTC of Southern Nevada	not sure
TX	City of Arlington	Was not required for our deployments
TX	City of Frisco	N/A
TX	Metropolitan Transit Authority of Harris County	The more detail the better and to include picture and graphics
TX	Texas DOT	I would refer you to the lead agencies, which we have POCs for all of them.
UT	Utah DOT	We operated at multiple sites. It was usually less than three months, but in a case or two it took longer than three months. Plan ahead and expect a few questions. We often had to install poles and signs along the corridor to provide localization to the shuttle and to warn pedestrians and drivers in the area that the shuttle was operating there. We had to plan carefully for nighttime storage and charging and plan the route to that location (which needs approval, even though the operator is in control on that pathway). NHTSA runs all of these waivers through one person, and the regional office is not involved. It seems that, especially with well-known and experienced shuttle companies (and deployers, since we deployed in multiple locations), the process could be shortened. It seems too intense for most normal deployments. It takes too long.
VA	Virginia DOT	I was not involved in the submission process other than to review the infrastructure changes discussed.

18.0 Were any special authorizations required from the State Department of Motor Vehicles or other local/state agencies?



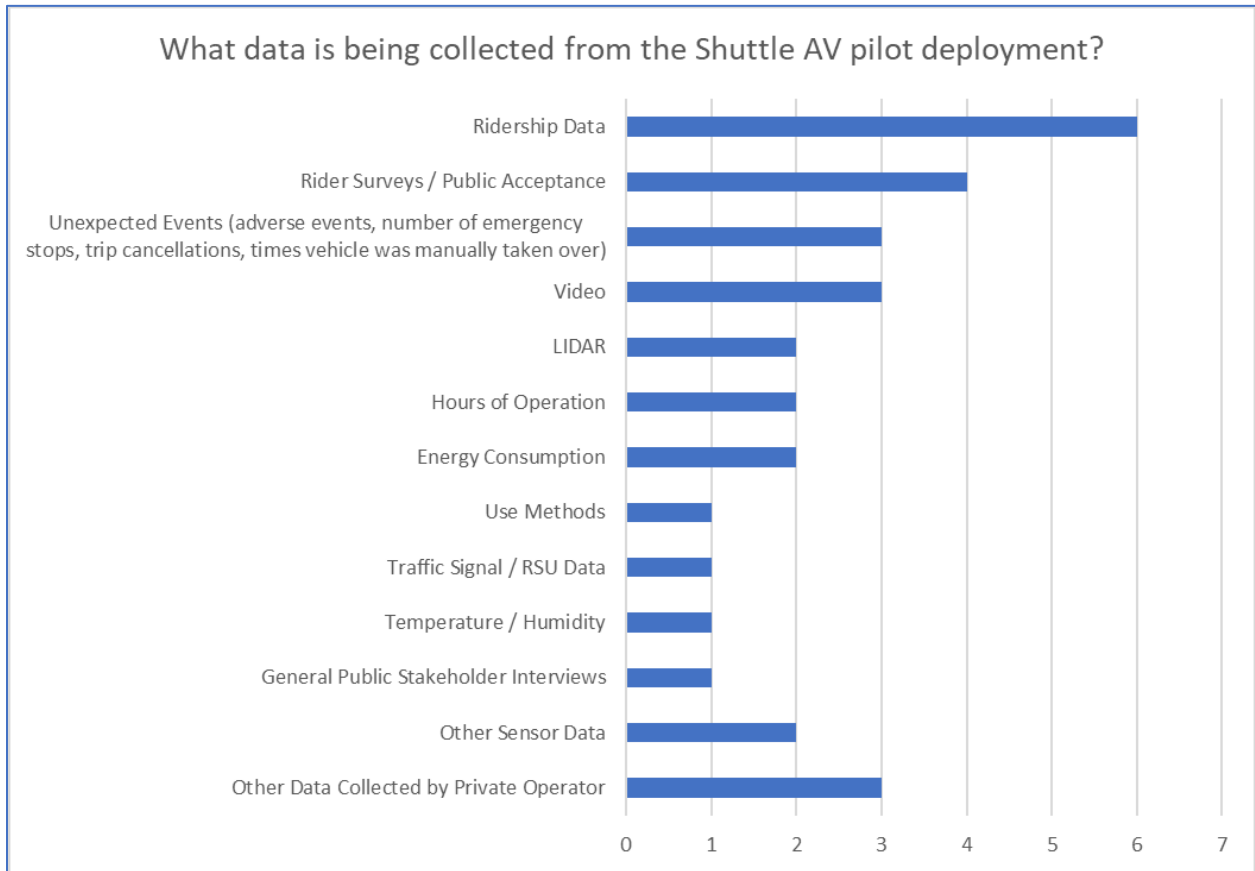
State	Agency	Response
FL	City of Gainesville RTS	Not yet
MD	Maryland DOT MVA	MD DOT MVA has a permit process for on-road testing of highly automated vehicles (SAE Levels 3, 4, & 5)
MN	Minnesota DOT	No, however we coordinated with our safety officials
NJ	New Jersey DOT	There exists a current legislative task force looking at AV and what changes might be needed and impacts of AV on a broad spectrum of areas.
NV	City of Las Vegas	NV DMV requires registration of autonomous vehicles. See their website at: dmv.nv.com/autonomous.htm
NV	RTC of Southern Nevada	State DMV is actively involved with AV projects; a special license plate is required for AVs
TX	City of Arlington	no
TX	City of Frisco	No
TX	Metropolitan Transit Authority of Harris County	No
TX	Texas DOT	No. Our laws don't require it. We did coordinate with both DPS and DMV on all deployments and still do. Licensing issues were managed with DMV.
UT	Utah DOT	We obtained a license plate for the shuttle. I'm not sure it was necessary - although it may have been when we operated on a public street.

19.0 Were law enforcement and/or emergency services involved during initial deployment on public roads?

State	Agency	Response
FL	City of Gainesville RTS	No. Only prior to start the service
MD	Maryland DOT MVA	yes, from the beginning of each project local emergency responders are actively involved
MN	Minnesota DOT	We are currently planning to coordinate with local agency law and emergency professionals but have not to-date.
NV	City of Las Vegas	city Marshals were involved to monitor traffic and operations on the initial days of operations. LVMPD should have been contacted. There was a workshop after a few months of operation to introduce emergency response personnel to the vehicle and provide an overview.
NV	RTC of Southern Nevada	No direct role
TX	City of Arlington	yes, were trained on operations
TX	City of Frisco	Yes, we had roundtable discussions before launch where police and fire were able to ask questions and share situations for consideration. First Responders were also provided training on the operation for the vehicles and how to disarm in case of emergency.
TX	Texas DOT	Planning, familiarization, training for first responders on how to access and deal with specific AV vehicles in a crash, table top exercises with all stakeholders, public engagement, regular traffic management and law enforcement
UT	Utah DOT	At every site, we planned a pre-deployment safety meeting and invited local law enforcement and emergency services personnel. These weren't always well attended, but we wanted them to be aware of what we were doing. We also developed emergency response plans.
VA	Virginia DOT	The shuttle has yet to run.

20.0 AV Shuttle pilot deployment data

20.1 What data is being collected from the AV Shuttle pilot deployment? (e.g. video, LIDAR images)



State	Agency	Response
FL	City of Gainesville RTS	Video and LIDAR images
MN	Minnesota DOT	Video, lidar, other sensor data, traffic signal/RSU data, and qualitative data including general public stakeholder interviews and rider surveys.
NV	City of Las Vegas	The data that was provided to the city was hours of operation, ridership, times the vehicle was manually taken over, energy consumption, etc. The technology company kept the LiDar, video, and onboard operational data.
NV	RTC of Southern Nevada	Data is collected by the private operators
TX	City of Arlington	ridership, adverse events, trip cancellations
TX	City of Frisco	The TMA only received ridership data. Drive.ai collected and owned all other data.
TX	Metropolitan Transit Authority of Harris County	In partnership with the Center for Transportation & Research at Texas Southern University, the project has collected information on ridership, public acceptance, vehicle data, temperature, humidity and energy consumption
TX	Texas DOT	Passenger, surveys, use methods. I don't believe the leads required on-system sensor data, but can ask them.
UT	Utah DOT	We collected quite a bit of rider survey data. We also, in some instances, collected video of the riders to use in our research about rider trust. We collected basic operational data: hours of operation, number of riders, number of emergency stops, etc. We did not (were not allowed to) collect data from the vehicle sensors.
VA	Virginia DOT	The shuttle has yet to run.

20.2 What data elements do you find to be the most critical to glean from the OEMs for Shuttle AVs?

State	Agency	Response
FL	City of Gainesville RTS	Still collecting data and development procedures for data collection through the University. Data for research projects will include pedestrian detection, brake activation for incident detection, speed, location and passenger loads, smooth operation, etc.
MN	Minnesota DOT	<ol style="list-style-type: none"> 1. How they operate in other climates (snow/cold/ice/fog) 2. How to engage the public to develop pilots that meet their needs (as opposed to simply placing pilots in various communities) 3. Affordability and accessibility of autonomous shuttles 4. Disengagement, near miss data 5. Public acceptance and trust of AVs
NV	City of Las Vegas	Number of hard stops, times the operator had to take manual control, the hours of operation versus the downtime, ridership.
NV	RTC of Southern Nevada	This needs to be discussed with the private operators
TX	City of Frisco	Ridership, wait times, repeat users, requests for service modifications. It would be nice in the future if data could be used for traffic conditions, asset conditions (pavement marking conditions, missing signage, etc).
TX	Metropolitan Transit Authority of Harris County	Vehicle data, ridership and battery range
TX	Texas DOT	Will have to ask leads.
UT	Utah DOT	The data we collected was useful. I'm not sure what we would have done with the sensor data, but having it might have shed some light on possible uses.
VA	Virginia DOT	The shuttle has yet to run.

21.0 Are details agreements/arrangements from the deployments available to share including requests for information or proposals, operational agreements, data sharing agreements?

State	Agency	Response
FL	City of Gainesville RTS	No
MN	Minnesota DOT	Yes
NV	City of Las Vegas	Yes
NV	RTC of Southern Nevada	No
TX	City of Arlington	Yes
TX	City of Frisco	Yes
TX	Metropolitan Transit Authority of Harris County	Yes
TX	Texas DOT	Yes
UT	Utah DOT	Yes

22.0 Top 3 lessons learned since deploying Shuttle AVs

State	Agency	Response
FL	City of Gainesville RTS	• New guidelines needs catch up with deployments
		• New State and Federal regulations need update
MN	Minnesota DOT	• We need documented best practices from other states, maybe even a checklist, on items needed and things to consider
		• Need a strong risk matrix to manage schedule, budget and legal risks
		• These take more time, oversight, and money to deploy and the long-term operations and maintenance costs are unclear.
NV	City of Las Vegas	• People are excited and want AV shuttles
		• Involve emergency response personnel
		• Obtain political support
NV	RTC of Southern Nevada	• Public response
		• Public agency collaboration
		• Interaction with the private vendors
TX	City of Arlington	• Relationship with vendor makes all the difference
		• Technology can perform at mostly the same level across all platforms/vehicles
		• Deployments are expensive
TX	City of Frisco	• People were willing to ride in an AV shuttle
		• Involve first responders
		• Public Private partnerships could successfully launch AV deployments
TX	Metropolitan Transit Authority of Harris County	• Public adoption/response is good/Vehicle is safe
		• Battery usage could be a challenge
		• Needs to be fully ADA compliant
TX	Texas DOT	• For it to be a continuous deployment, must have a viable business case that generates profit
		• Extensive planning and coordination and pre-deployment exercises are recipes for success
		• AV is still in development, all the safety protocols and mitigation won't prevent everything, you must have plans for the inevitable
UT	Utah DOT	• We believe that these shuttles can be useful in a transit network, but not until the mechanical reliability is improved and the vehicle is capable of navigating around basic obstacles.
		• When selecting an operational location, the storage and charging location and arrangements are more crucial than we thought. The shuttle is too tall for a typical garage, needs a warm place to charge (indoor), and needs routine maintenance on the site where it is deployed.
		• The public accepts these vehicles, feels safe in them (in this low-speed operating environment), and will ride them.

23.0 Did you have procurement challenges in getting the Shuttle AV?

State	Agency	Response
FL	City of Gainesville RTS	Buy America compliance is the main challenge
MN	Minnesota DOT	No. We used our new innovative procurement process, the Minnesota CAV Challenge.
NV	City of Las Vegas	It was privately funded so no procurement process
NV	RTC of Southern Nevada	not aware of significant challenges
TX	City of Arlington	We used sole source procurement for EasyMile and competitive RFP for Drive.ai deployment.
TX	City of Frisco	No
TX	Metropolitan Transit Authority of Harris County	No
TX	Texas DOT	have to ask the leads for details, there were early challenges with EasyMile procurements/contracts. May have been vehicle availability
UT	Utah DOT	Not really. We were able to use a "test procurement" method, where we could pretty easily select a company and write a fixed-term contract for a lease (less than 18 months).

24.0 Cost range for a single shuttle (purchase or lease)

State	Agency	Response
FL	City of Gainesville RTS	Do not know. Vendor is responsible for turn key operation including vehicles
MN	Minnesota DOT	\$800,000 for a 1 year pilot with 1 shuttle (lease)
NV	City of Las Vegas	The quote that was provided to us was on the order of \$500k for lease and staffing to operate it.
NV	RTC of Southern Nevada	\$200 to \$400k
TX	City of Arlington	EasyMile - \$272K lease for 2 shuttles Drive.ai - \$434K all inclusive (operations, maintenance, turnkey for 4 vehicles)
TX	Metropolitan Transit Authority of Harris County	Lease amount for approximately \$36,000 per month for 6 months
TX	Texas DOT	have to ask leads
UT	Utah DOT	We leased for one year for about \$325k. That included a full-time operator, who also transported and maintained the vehicle. This also included transportation and site set-up for nine distinct sites. We paid extra for a second operator to extend our working hour limits. There were other costs for public relations, on-site ambassadors, a web site, site adaptation (localization signs, etc), research and testing, etc.

25.0 Length of demonstration period

State	Agency	Response
FL	City of Gainesville RTS	3 years
MN	Minnesota DOT	1 year
NV	City of Las Vegas	10 months
NV	RTC of Southern Nevada	shuttle was one year; Aptiv project is ongoing for two+ years
TX	City of Arlington	EasyMile - 1 year, Drive.ai 6 months
TX	City of Frisco	9 months
TX	Metropolitan Transit Authority of Harris County	9 months
TX	Texas DOT	Typically 6 months to a year
UT	Utah DOT	12 months, on about nine sites.

26.0 Was the service open to the public or a select focus group?

State	Agency	Response
FL	City of Gainesville RTS	Both
MN	Minnesota DOT	Public
NV	City of Las Vegas	Public
NV	RTC of Southern Nevada	Public
TX	City of Arlington	Public
TX	City of Frisco	Select Focus Group
TX	Metropolitan Transit Authority of Harris County	Both
TX	Texas DOT	Public
UT	Utah DOT	Public
VA	Virginia DOT	Public

27.0 What are your next steps to deploy future driver-less vehicles in your region?

State	Agency	Response
FL	City of Gainesville RTS	Do not know. Need to finish project first
MD	Maryland DOT MVA	Continue collaboration with any entities that wish to research, test and implementing CAVs in Maryland
MN	Minnesota DOT	Scale this pilot and replicate in other parts of the state, including rural areas
NV	City of Las Vegas	Obtain additional funding to continue program. RTC/City also received federal grant for project that includes AV shuttles, GoMed.
NV	RTC of Southern Nevada	tbd
TX	City of Arlington	We recently won an FTA IMI grant and will be partnering with May Mobility and Via to use AV shuttles in our university area that are integrated with the Via app and payment system, including ADA accessible vehicles.
TX	City of Frisco	Secure funding in a time frame that is quick enough to execute a project. Government funding does not align with the speed of these vendors (and their turnover).
TX	Metropolitan Transit Authority of Harris County	The pilot is moving the Phase II where it will operate in mixed traffic. Once Phase II is successful the service can be reviewed for integration into the public transit system
TX	Texas DOT	Continue to identify use cases that marry with Business opportunities, seeking to find deployments that actually address community needs while being profitable for businesses, rather than pilots or demonstrations.
UT	Utah DOT	UDOT is considering some other AV testing and demonstrations, likely not another low speed shuttle. UTA is interested in extending the shuttle deployments and exploring more completely the integration of the shuttle into a transit route.