VTRC
Virginia Transportation Research Council

We bring innovation to transportation.

Automated Shuttles in Virginia

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RRTPO Community Transportation Advisory Committee
November 19, 2020

Automated Shuttles

- Low-speed, ~15 mph
- Operator on board
- Follow strict path, no deviations
- Pre-mapped route
- Needs differential GPS, lane markings, waypoints

Major US Deployments as of September 2018

Location	Project Partners	Vehicle Model	Shuttles	Type
Dublin, CA	Livermore Amador Valley Transit Authority, First Transit	EasyMile EZ10	1	Ongoing Pilot
San Ramon, CA	Contra Costa Transportation Authority, and Central Contra Costa Transit Authority (CCCTA), GoMentum Station, and Bishop Ranch	EasyMile EZ10	2	Ongoing Pilot
Gainesville, FL	Florida Department of Transportation, University of Florida, and City of Gainesville	EasyMile EZ10	1	Ongoing Pilot
Jacksonville, FL	Jacksonville Transportation Authority, Transdev, First Group, and Stantec	Multiple (including EasyMile EZ10, a Navya vehicle, and another shuttle TBD)	1-2 per model	Ongoing Pilot
Weymouth, MA	Optimus Ride, Lstar Ventures	Polaris GEM	5	Ongoing Piot
Ann Arbor, MI	Mcity (University of Michigan)	Navya ARMA	2	Ongoing Pilot
Detroit, MI	May Mobility, Bedrock	Polaris GEM	5	Ongoing Pilot
Las Vegas, NV	City of Las Vegas, AAA, Regional Transportation Commission of Southern Nevada, and Keolis	Navya ARMA	1	Ongoing Pilot
Greenville, SC	Greenville County, Robotic Research, and Robocist	Cushman Shuttle 6, Local Motors Olli, and possibly others TBD	2+	Ongoing Pilot
Arlington, TX	City of Arlington	EasyMile EZ10	2	Ongoing Pilot

Deployments in Virginia

- Crozet
- Virginia Tech, Blacksburg
- Reston
- Joint Base Myer-Henderson Hall, Arlington (Phase 1 completed)
- Fairfax County, Dunn Loring Metro (planned)

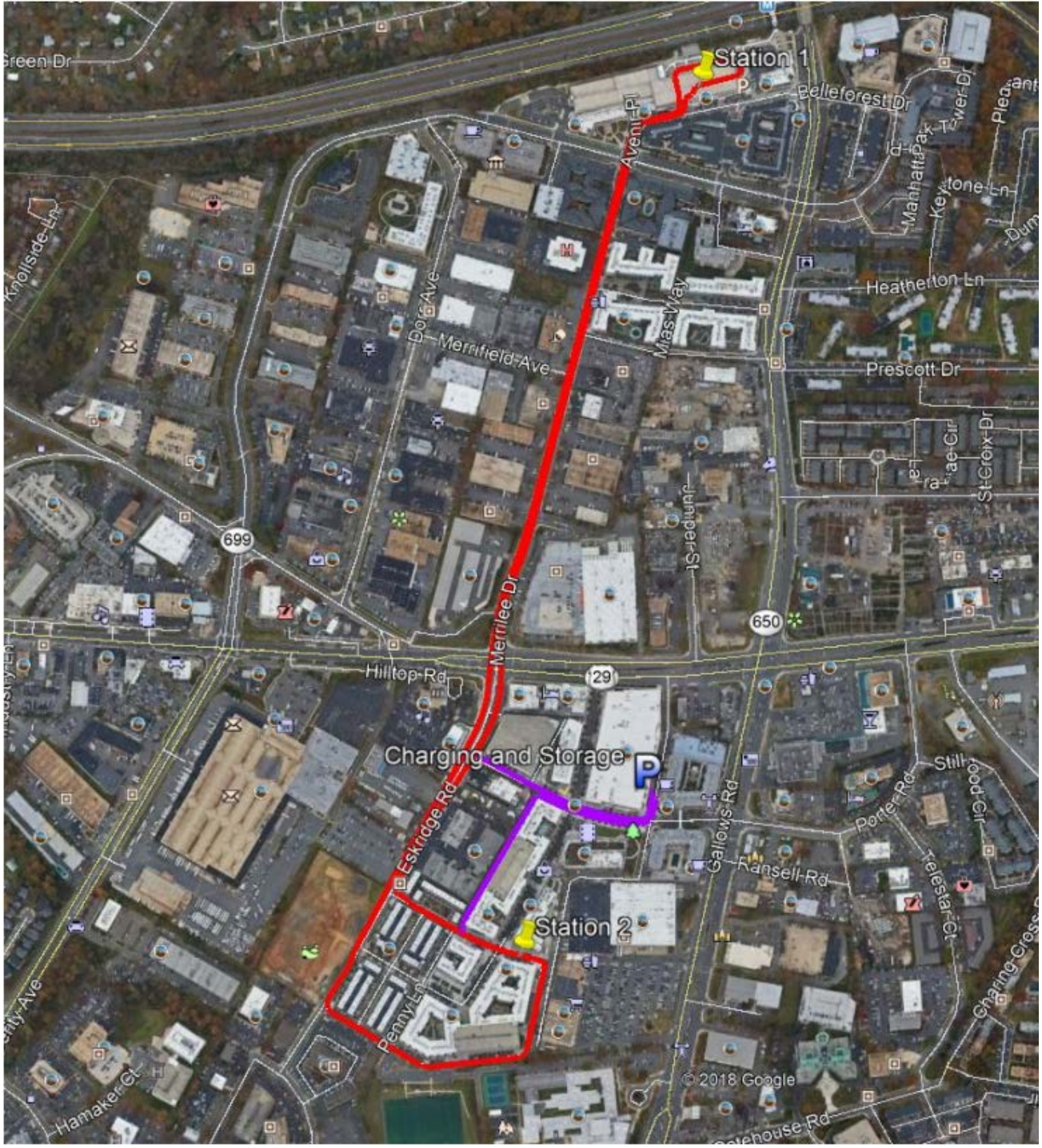
VDOT Supporting

Joint Base Myer-Henderson Hall

- Olli by Local Motors
- Phased 1, base roads with traffic
- Tailgating and aggressive driving were challenges
- Phase 2 planned on public roads, connect to Pentagon Metro

Fairfax County – Dunn Loring Metro

- “Relay” EZ10 by EasyMile
- 3 passenger limit
- Service between Mosaic District and Dunn Loring Metro
  - 10am-2pm, M-Th
  - 2.3 mile loop
- Operational as of October 22


Station 1
Belleforest Dr
Avent Pl
Manhattan Park Tower Dr
Keystone Ln
Heatherton Ln
Prescott Dr
Knollside Ln
Borg Ave
Merrifield Ave
Mas Way
Juniper St
St Croix Dr
699
650
29
Hilltop Rd
Merrilee Dr
Charging and Storage
Eskridge Rd
Gallows Rd
Porter Rd
Stillwood Cir
Ransell Rd
Telestar Ct
Station 2
Penny Ln
Hamaker Ct
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VDOT Signal Support

- **Problem:**
  - Shuttle top speed is 12 mph
  - Crossing Lee Highway requires 17 seconds
  - Yellow + Red clearance time = 6.0 seconds
  - Vehicle needs 11 s of green
- **Solution:**
  - Transit signal priority, vehicle requests 15 seconds of green
  - Signal transmits remaining green time to shuttle operator using dedicated short-range communications

Other VDOT Support

- Pavement markings (needed for vehicle localization)
- Additional warning / regulatory signage
- Tree trimming (interferes with vehicle sensors)
- Grass trimming

Multi-Agency Effort

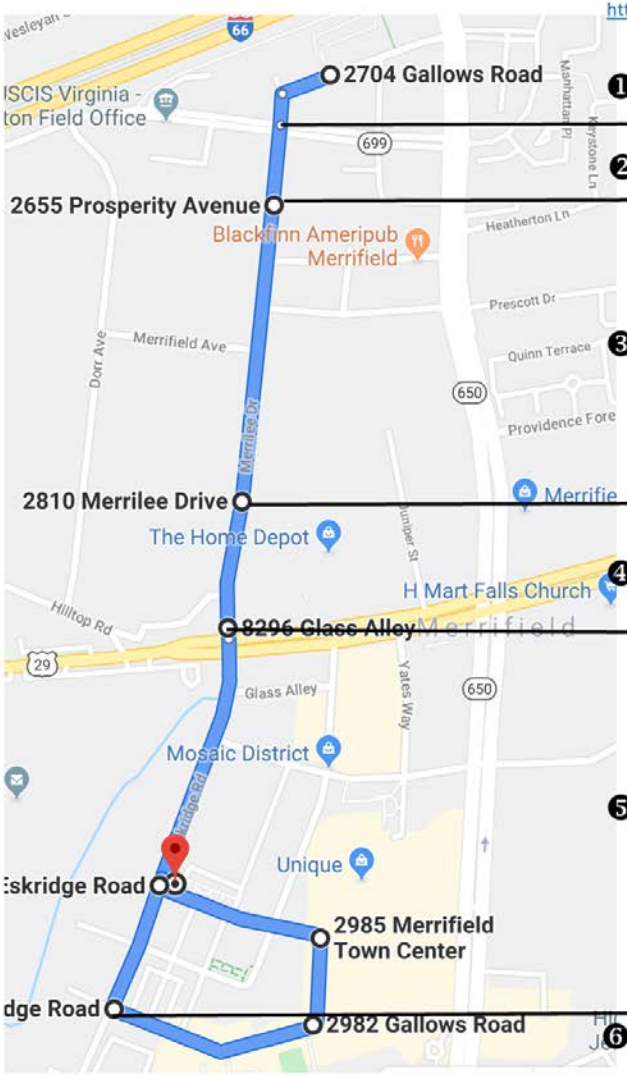
- VDRPT – $250k grant
- EasyMile – vehicle manufacturer
- Transdev – shuttle operator
- Fairfax County – $50k match and coordination
- VDOT – signal and signage support
- VTRC – coordination and research support
- VTTI – data collection and research
- George Mason – Research surveys
- Edens – Owner of Mosaic, site support
- WMATA – Dunn Loring site support

Regulatory Agency Involvement

- Department of Motor Vehicles
  - Registration
- Virginia State Police
  - Safety inspection
- Local jurisdictions
  - Markings
  - Signs
  - Signals
- National Highway Traffic Safety Administration
  - Shuttle compliance with Federal Motor Vehicle Safety Standards
  - Continued monitoring
  - Vehicle import

Roadway Ownership for Fairfax Autonomous Shuttle Route

https://goo.gl/maps/DtSYq6zzngTPh8SK6



1. Merrilee north of Prosperity: Private roads
2. Merrilee between Prosperity intersection and appx. 2655 Prosperity:
   Developer built, Fairfax County own
   To be turned to VDOT
3. Merrilee between appx. 2655 Prosperity and north of Home Depot: VDOT road
4. Merrilee between north of Home Depot and Lee Highway:
   Owned by Fairfax County Board of Supervisors
   Not a public right-of-way
5. Eskridge between Lee Hwy and Merrifield Cinema Dr:
   Built by developer
   Fairfax County has the right-of-way
   It is a public road anticipated to be accepted by VDOT in July – Oct 2020 timeframe.
6. Eskridge between Merrifield Cinema Dr and Williams Drive :
   Built by Fairfax County and it has the right-of-way. It is a public road anticipated to be accepted by VDOT in April – May 2020 timeframe.

For private roads (#1, #4, and roads within Mosaic District): property owner has the responsibility for signs, marking, etc.

For public roads that have not been accepted by VDOT (#2, #5) – Fairfax County has the right-of-way can install signs and marking or request developers to do so. County and developer will generally install signs to meet VDOT standards to ease the future transition to (accepted by) VDOT.

For public road that VDOT has accepted (#3) – VDOT has the responsibility for signs, marking, etc.

Next Steps

- Shuttle to operate for one year
- Virginia Tech Transportation Institute under contract to study shuttle performance
  - Internal and external video
  - Kinematic data (3-axis acceleration and speed)
  - Logging and off-line analysis of safety critical events
- George Mason University conducting rider surveys
- Virginia Transportation Research Council documenting:
  - Regulatory challenges
  - Institutional issues
  - Lessons learned

Challenges for DOTs / Municipalities

- If made in U.S. with standard controls (FMVSS compliant), no NHTSA waiver needed
- If made abroad with non-standard controls, NHTSA waiver needed
- Very low speedsManual control capabilities vary widely
- Unprotected left turns very challenging
- Lots of attention from media and regulators

National Transportation Safety Board

Washington, DC 20594

Highway Accident Brief

Low-Speed Collision Between Truck-Tractor and Autonomous Shuttle, Las Vegas, Nevada, November 8, 2017

Accident Number:	HWY18FH001
Accident Type:	Collision involving automated test vehicle on public road
Location:	South 6th Street, Las Vegas, Nevada
Date and Time:	November 8, 2017, 12:07 p.m. Pacific standard time
Vehicle 1:	2006 International truck-tractor in combination with 2010 Utility refrigerated trailer
Vehicle 2:	2017 Navya Arma autonomous shuttle
Fatalities:	0
Injuries:	0

Figure 8. Closeup of damage to lower left front of shuttle (photo taken 3 days after collision).

Figure 3. Truck-tractor after collision, with inset showing damage to right front tire (photo taken 4 days after collision).

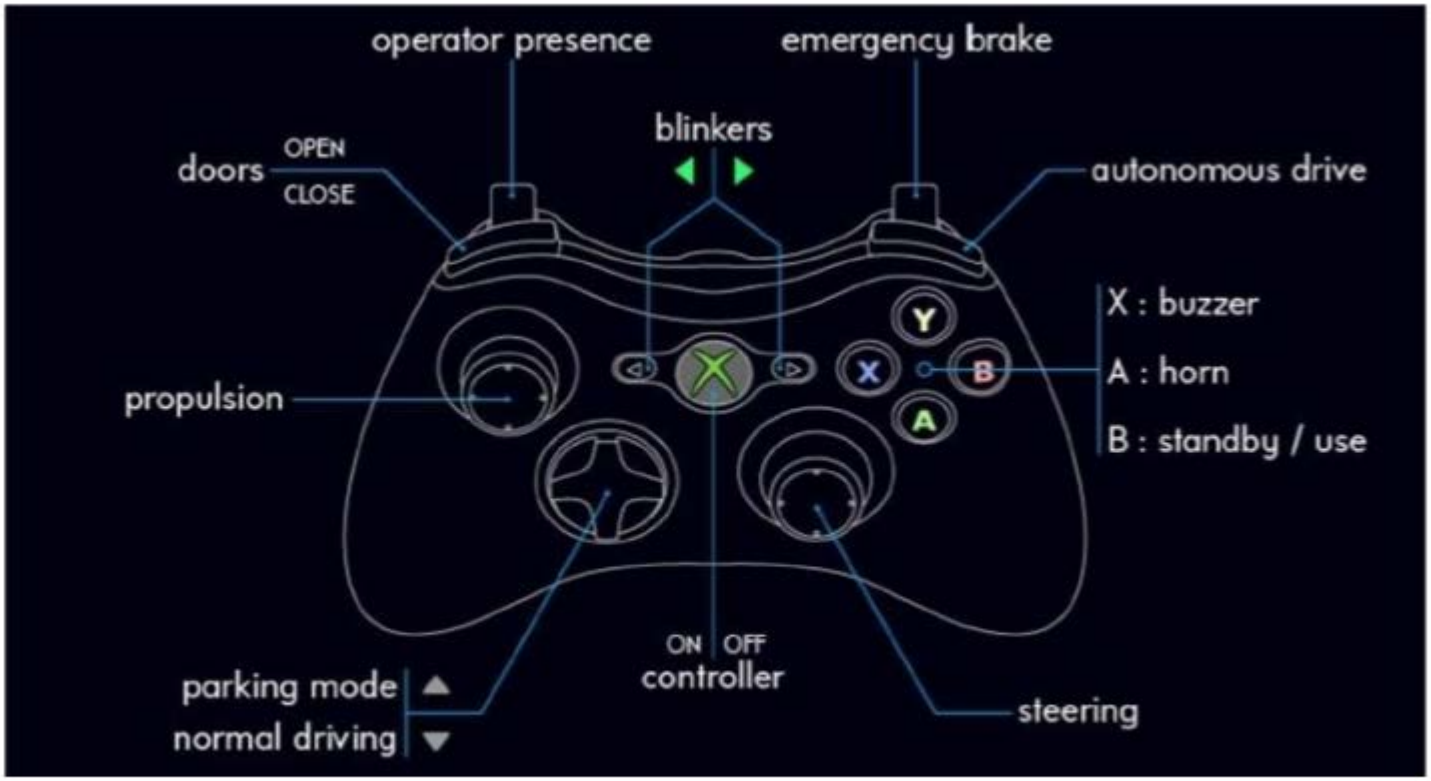


Figure 7. Schematic of controller used to operate shuttle in manual mode or return it to autonomous mode. (Source: Navya operator training booklet)

For more information

- Relay website:
  - https://www.fairfaxcounty.gov/transportation/autonomous-shuttle-pilot
- Noah Goodall
  - noah.goodall@vdot.virginia.gov
- Media coverage
  - https://www.youtube.com/watch?v=-qq6g-hgoVs
- Crossing US-29
  - https://twitter.com/NoahGoodall/status/1319472177989779458