



NORTH CAROLINA

Department of Transportation



Multimodal Innovations Webinar Series

Autonomous Vehicles/ Connected Autonomous Shuttle Supporting Innovation

June 22, 2021



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- ✓ Attendance is automatically recorded.



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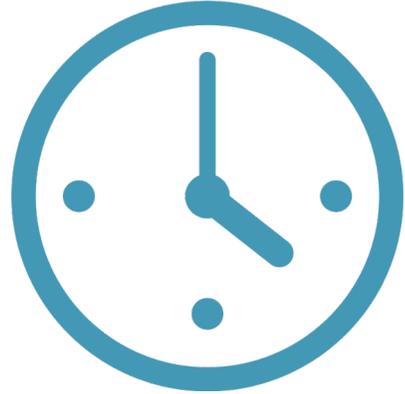
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Completion Requirements



Attend entire session



Active participation

Learning Objectives

- Recognize connected and autonomous technologies
- Recognize the level of maturity or readiness of these technologies for public use now
- Identify recent real-world public-private partnership autonomous deployment example in the US, as well as a local example of an NCDOT deployment of an autonomous shuttle
- Identify the near future application of these technologies to enhance and improve transportation, especially in the public transportation arena

Today's Speakers



**Elizabeth (Eli)
Machek**

Operations Research Analyst
Volpe National Transportation
Systems Center, USDOT



Angie DeVore

Manager, Administrative
Support Services and Project
Management
Valley Metro



Joseph Gregory

Manager of Geographic and
Service Planning
Valley Metro



Stephanie Sudano

Multimodal Special Projects
Engineer
North Carolina Department of
Transportation

Overview of Transit Bus Automation Research and Demonstration Activity

June 22, 2021

Elizabeth Machek, U.S. DOT Volpe Center

Disclaimer

Statements made during this presentation are opinions of the speaker and do not represent official positions of the U.S. Department of Transportation.

Overview: Driving Automation

Defining driving automation

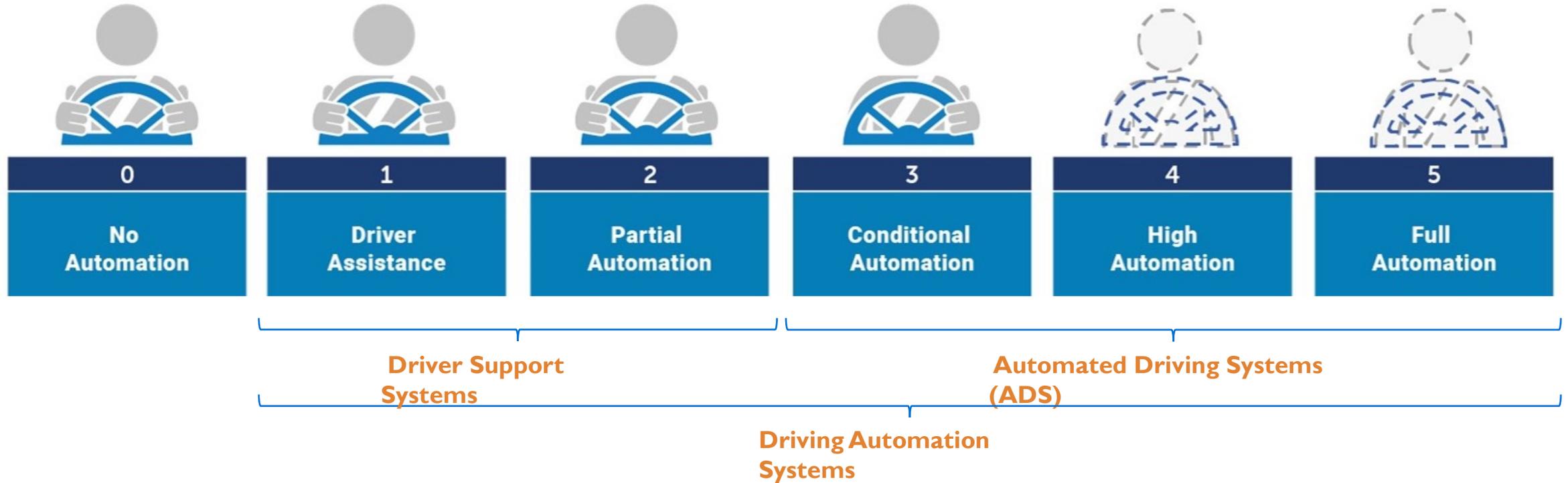


Image Source: U.S. DOT (Adapted from SAE J3016 Standard - see SAE J3016 website ([link](#)) and SAE J3016 diagram ([link](#)))

See also, SAE J3016 “Taxonomy and Definitions for Terms Related to Cooperative Driving Automation for On-Road Motor Vehicles” ([link](#))

It can be hard to make sense of the headlines

The Costly Pursuit of Self-Driving Cars Continues On. And On. And On.

Many in Silicon Valley promised that self-driving cars would be a common sight by 2021. Now the industry is resetting expectations and settling in for years of more work.

New York Times, May 24, 2021

Automation Isn't About to Make Truckers Obsolete

by Maury Gittleman and Kristen Monaco

September 18, 2019

Harvard Business Review

'Self-driving' cars to be allowed on UK roads this year

BBC News, April 28, 2021

TECH

Elon Musk Says Tesla Vehicles Will Drive Themselves in Two Years

BY KIRSTEN KOROSEC

December 21, 2015 11:00 AM PST

Fortune

Driverless Cars Are Already Here

Jens Wohltorf 2:00 PM PDT • June 17, 2015

TechCrunch

 Comment

G.M. Says Its Driverless Car Could Be in Fleets by Next Year

By Neal E. Boudette

Jan. 12, 2018

New York Times, January 12, 2018

Driving automation is here, and also not here

What is available today?

- Level 1-2 features in production vehicles
- Level 4 in closed environments and on guideways (e.g., automated people movers, mining, and agriculture)

What is being tested?

- Levels 1, 2, and 3 (e.g., truck platooning)
- Level 4 prototypes, largely with safety operators, though some are unstaffed

Here Today



Level 1



Level 2

In Testing



Level 3



Level 4

Someday (?)



Level 5

Diverse vehicle concepts are being explored



Image Source: U.S. DOT Volpe Center



Image Source: Phoenix Motorcars via EasyMile



Image Source: Santa Clara VTA



Image Source: Arlington, TX



Image Source: New Flyer



Image Source: Gunma University

Transit Bus Automation Research: Introduction

Overview: transit automation today

- Systems being tested and demonstrated are prototypes
 - Not yet ready for commercialization (speed, operation)
- Projects are sponsored by diverse agencies – not just transit
 - Funding from nonprofits, economic development, etc.
- Early projects struggled with Federal regulations (ADA, FMVSS, Buy America, etc.)
 - Slow improvement as FTA demonstrations have clarified need for compliance
- Accessibility research is underway but currently many challenges remain

FTA has a transit automation research plan

Strategic Transit Automation Research (STAR) Plan

- FTA's five-year research plan on automation for transit buses
- Published in January 2018
- Establishes a research and demonstration framework
- Leverages the core strengths of academia, public institutions, and private sector

Complementary Work Areas

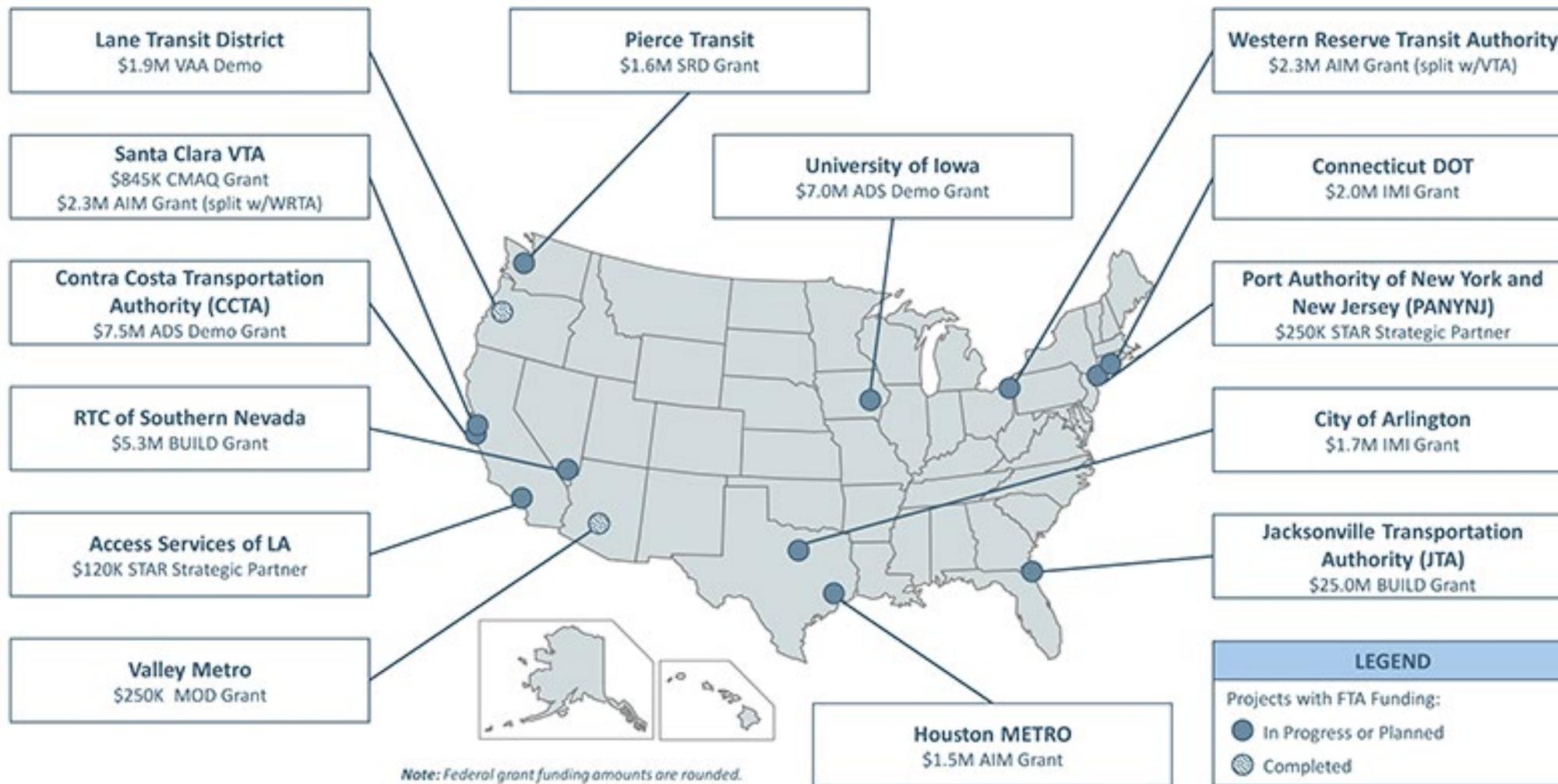
- Enabling Research
- Integrated Demonstrations
- Strategic Partnerships
- Stakeholder Engagement / Knowledge Transfer



STAR Plan available at:

<https://www.transit.dot.gov/research-innovation/strategic-transit-automation-research-plan-report-0116>

FTA Automated Bus Project Overview



FTA Automated Bus Project Highlights

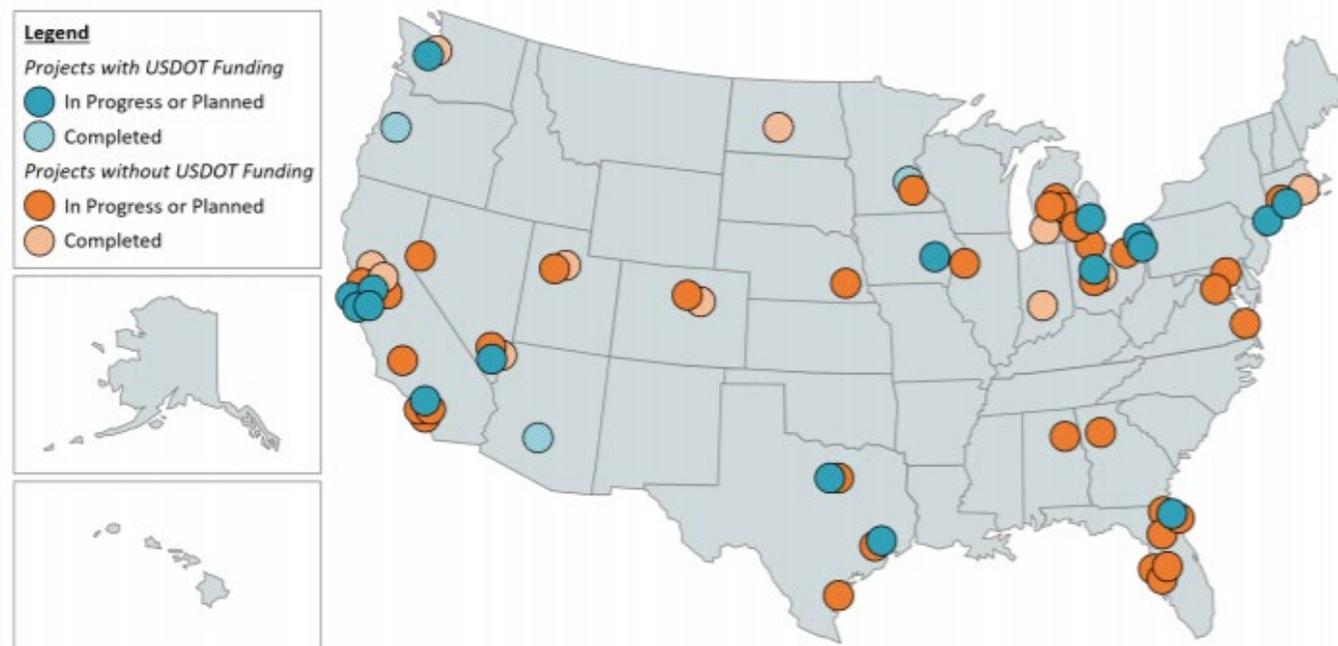
- **Integrated Mobility Innovation (IMI)**
 - CTDOT CTfastrak BRT L4 bus unveiled ([link](#))
 - Arlington, TX project launch with Via and May Mobility ([link](#))
- **Accelerating Innovative Mobility (AIM)**
 - WRTA and Santa Clara VTA issue RFP ([link](#))
 - Kickoff for Houston METRO (L4 bus)
- **ADS Demonstration Grants**
 - CCTA
 - Detroit, MI
 - University of Iowa



FTA Automated Transit Bus Publications

- Transit Bus Automation Policy FAQs ([link](#))
- Transit Bus Automation Market Assessment ([link](#))
 - *2021 update later this year*
- Transit Bus Automation Quarterly Update ([link](#))

U.S. Transit Bus Automation Testing Activities



Source: USDOT Volpe Center, April 2021

FTA Automated Transit Bus Publications

- Assessing Transit Providers' Internal Business Case for Transit Bus Automation ([link](#))
- Insurance and Liability for Automated Transit Buses: State of the Practice Review ([link](#))
- Survey Research for Automated Shuttle Pilots: Issues and Challenges ([link](#))



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Our Purpose

Advancing transportation innovation for the public good.

OUR CORE VALUES



Public Service



Innovative Solutions



Collaboration and Partnering



Professional Excellence



Employee Well-Being

Driving the Future of Transportation

Valley Metro – Waymo Partnership Automated Vehicle Mobility on Demand (AV MOD) Project



Federal Transit Administration



CONNECT
COMMUNITIES

ENHANCE
LIVES

VALLEY METRO, PHX
ARIZONA

Valley Metro Agency Overview



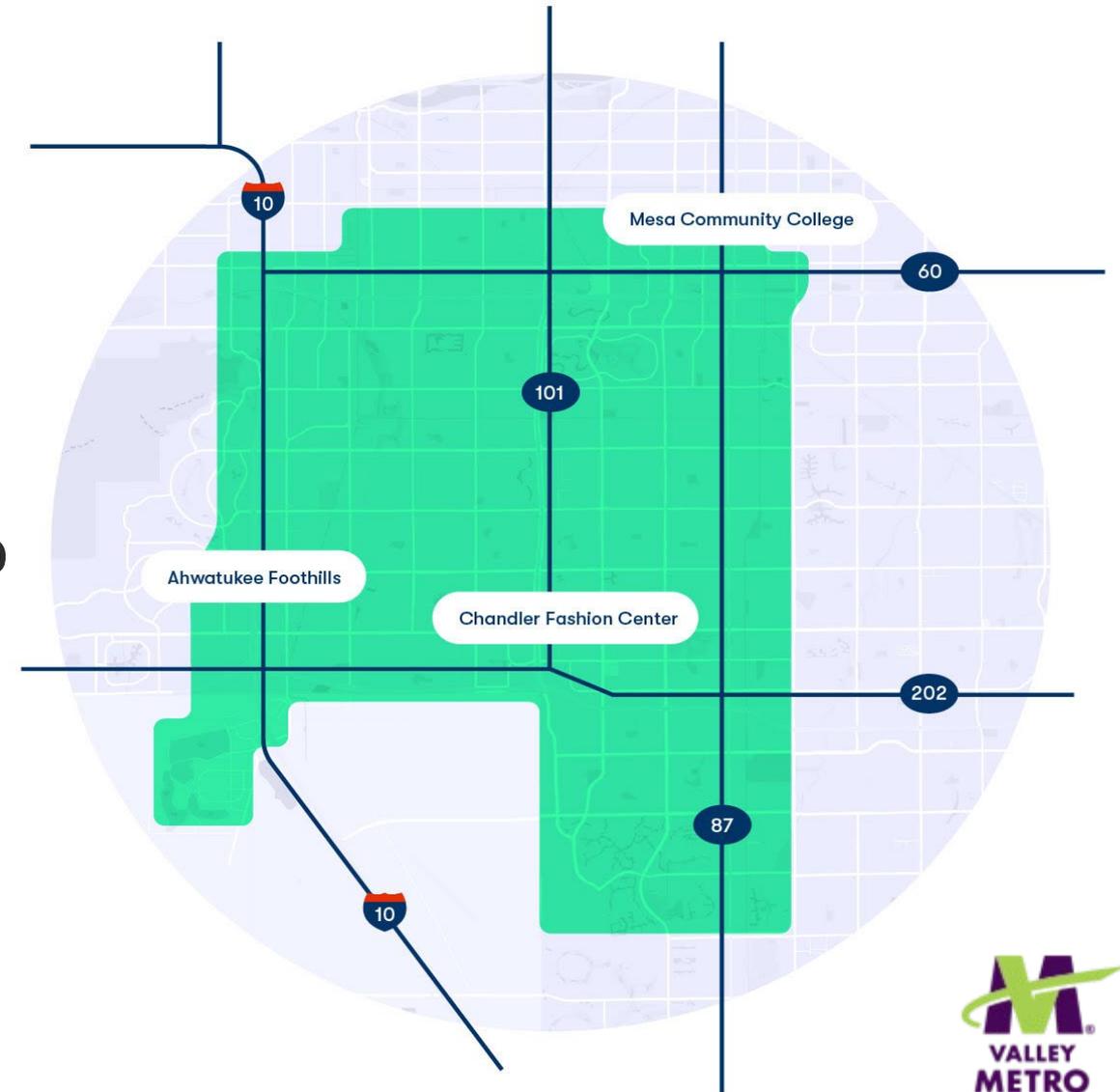
Autonomous Vehicle (AV) Demo

- \$250K extra awarded for “demo”
- Data collection to learn lessons
- RideChoice program (AV Pilot) was a natural fit



Valley Metro's Partnership with Waymo

- Rides for ADA paratransit-certified people with disabilities and seniors aged 65 and over
- Living or traveling within the Waymo service area of the Greater Phoenix region
- Highly subsidized rides at \$3 fixed fare



What Did We Want to Learn?

Data and Information Collection Plan

Conduct research to learn how new types of mobility service delivery integrating on-demand, self-driving cars can:

- Enhance customer experience and satisfaction
- Meet mobility and accessibility needs of transportation disadvantaged population
- Improve safety and affordability



Phase I – Employee Pilot

(not part of MOD Sandbox)

- Average Trip Star Rating – 4.7
- 72% of trips rated at 5 stars
- How was Waymo used?
- Willingness to pay
- Attitudes toward self-driving cars – more positive



Photo Source: CNET

Pilot Experience

- Sought to understand how different service types could integrate with the existing transit system.
- Explored solutions to first mile/last mile connectivity, especially in regard to commuter express services.
- Tested technology response to different traffic environments, movements, and pick up/drop off locations.



Phase II – RideChoice Customers



AV MOD Project Overview

- ASU administered series of online surveys
- Recruitment conducted by Valley Metro and Waymo
 - 72 people submitted an Interest Form
 - Limited to RideChoice participants residing in service territory
 - Participants meeting the criteria were selected to participate
 - 51 submitted a pre-survey
 - 29 were riding consistently
- 1143 RideChoice rides taken

Overview of Survey Data

- ASU deployed surveys on three occasions: before, during, and after the AV MOD service was provided as a RideChoice option
- Surveys aimed to capture:
 - basic travel patterns/choices
 - perceptions and attitudes towards RideChoice program and Waymo service
- Comparisons across surveys provided insights on attitudinal and behavioral changes towards AV technologies and MOD services after using Waymo
- Basic demographic and socio-economic data about the individual and household were also collected

Project Outcomes and Key Findings



Phase II Project Outcomes

- Participants see the benefits of self-driving vehicles and want to have Waymo as a permanent RideChoice option.
- Overall, this special population is eager to use Waymo and would embrace self-driving vehicle services when available
- Some hesitation in sharing a driverless vehicle with strangers
- As expected, COVID-19 pandemic has significantly impacted participants' travel patterns.

Key Findings

Participants felt safe

Participants found the services more convenient than typical RideChoice options

Participants made new trips as a result of the new AV option

Participants embraced AVs as a mobility option

Participants are interested in riding alone, without a safety operator

Participants would like to be among the first to use AVs

Focus Groups and Next Steps



Focus Groups

- The rider focus groups tended to **confirm the findings of the surveys**
- Waymo gave riders a greater sense of safety and independence; **they are eager to use Waymo without a vehicle operator**
- The Subject Matter Experts (SME) focus group was **keen to see pilot projects** complementing transit services
- The Policy-Maker Roundtable felt there was a need to explore more use cases within the region



Technology Improvements



Financial Responsibilities



Data Sharing Issues



Collaboration Among Various Jurisdictions

Next Steps



Draft Report - 3/23/21



Final Report - 5/27/21



Waymo partnership ends 6/30/21; what's next?



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Project CASSI

Connected Autonomous Shuttle Supporting Innovation

Stephanie L. Sudano, PE, Multimodal Special Projects Engineer

June 22, 2021



Project CASSI



- NCDOT's AV Shuttle Initiative
 - Project Goals
 - Project Delivery Structure
- CASSI
 - The Shuttle
 - Partners
 - NCDOT Transportation Summit
 - NCSU Centennial Campus
 - Wright Brothers National Memorial
 - Next Deployment?
- Lessons Learned, Best Practices

Why this project?

Evaluate
Safety

Providing
opportunities
for partners

Study various
transit use cases

Solution for
Limited Mobility

Pilot: learning
about AV

Advance
Technology

Inform policy
and
rulemaking

Infrastructure needs

Ped & vehicular
interactions with AV

First
Mile/Last
Mile



Automated vehicles that accurately detect, recognize, anticipate, and respond to the movements of all transportation system users could lead to breakthrough gains in transportation safety



Project Goals

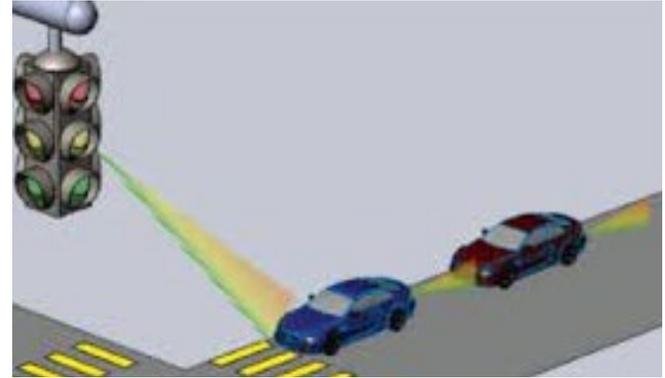


Integrated Mobility Division
N.C. DEPARTMENT OF TRANSPORTATION





North Carolina Division of Motor Vehicles



Learning about AV across
the agency...

- V2I Communications
- Improved Safety & Roadway Operations
- Infrastructure Design
- NC DMV Laws
- Research Entities



The CASSI Project Delivery Structure

Teams:



CASSI Transit Deployment Team

- NCDOT Division & Unit Leaders
- Crosscutting disciplines involved
- High level project guidance



CASSI Technical Oversight Team

- Small Team
- Route planning/safety focus
- Day to Day Oversight



CASSI Community Stakeholder Teams

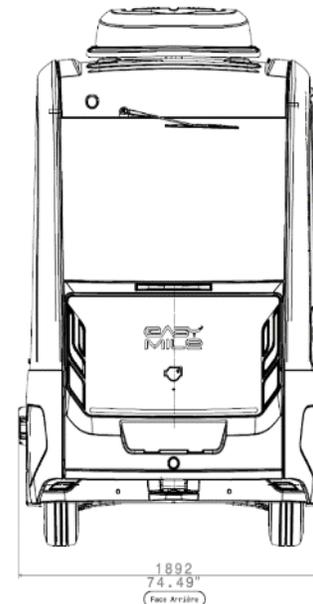
- Local leaders, city, town, and university
- EMS, Public Safety
- Communications



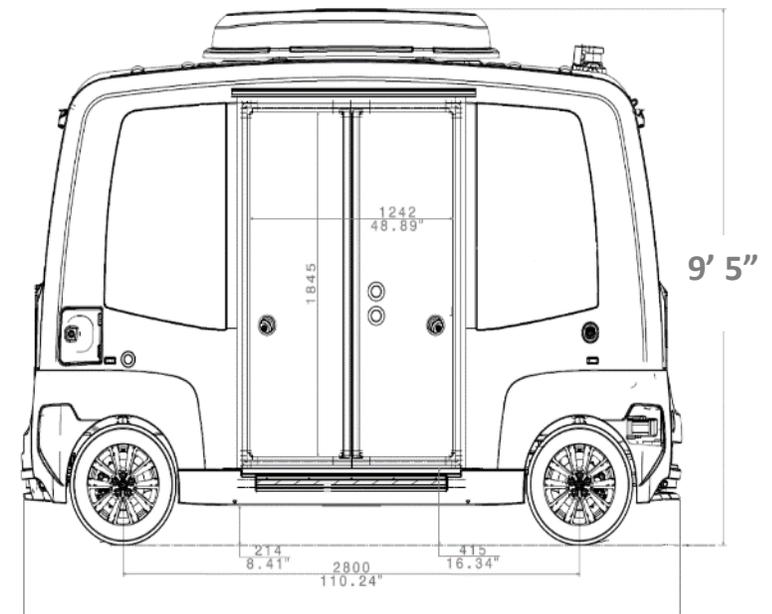
Connected Autonomous Shuttle
Supporting Innovation

The Shuttle

- EasyMile EZ10 Gen3 vehicle
- Driverless and electric shuttle
- Up to 16 hours of autonomous operations
- Accessibility ramp
- Fixed route
- Maximum operating speed 15 mph
- Level 4 automation
- (Temp) COVID-reduction capacity:
 - 5 from a household (plus operator)
 - 3 from different households (plus operator)
- Regular capacity 6 persons plus operator



6' 2"



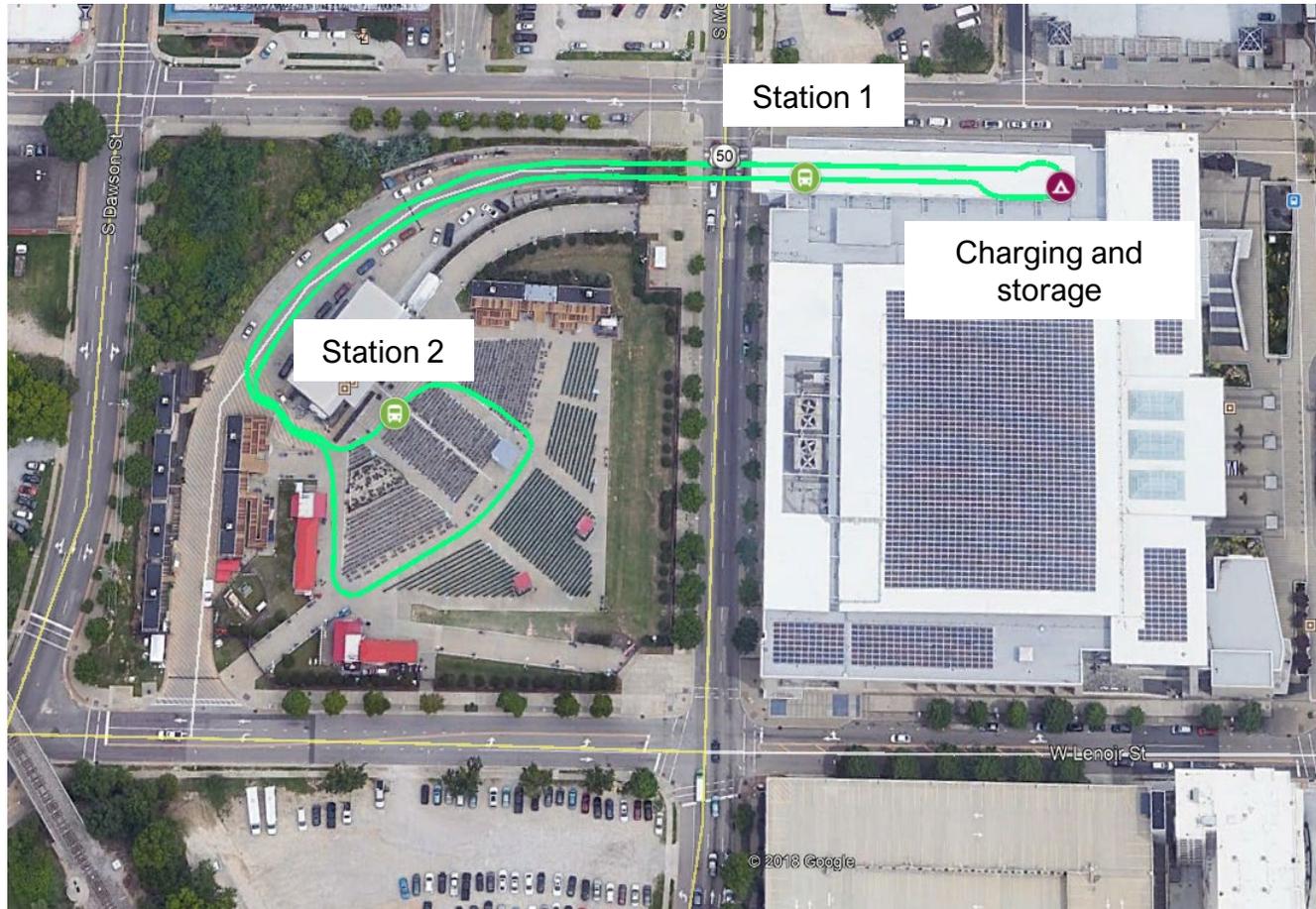
13' 4"



Project Partners



Deployment 1: NCDOT Transportation Summit Convention Center, Raleigh



- Dates: January 8-9, 2020
- Demo length: 2000 feet
- Maximum speed: 7-8 mph
- Available for Transportation Summit attendees
- Ridership around 300



- 3 weeks
- Ridership: 260
- Several service interruptions
- Early termination of deployment



Deployment 2: NCSU Centennial Campus

Deployment 2: NCSU Centennial Campus, Raleigh

- Dates Planned: January – June 2020
- Dates Actual:
 - Jan 21 – Feb 6 mapping & training
 - Feb 7 Public Launch
 - Feb 25 NHTSA suspension
 - March 10 Governor's Coronavirus SOE
- Demo length: 0.8 mi
- Maximum speed: 10 mph
- Available for anyone on campus





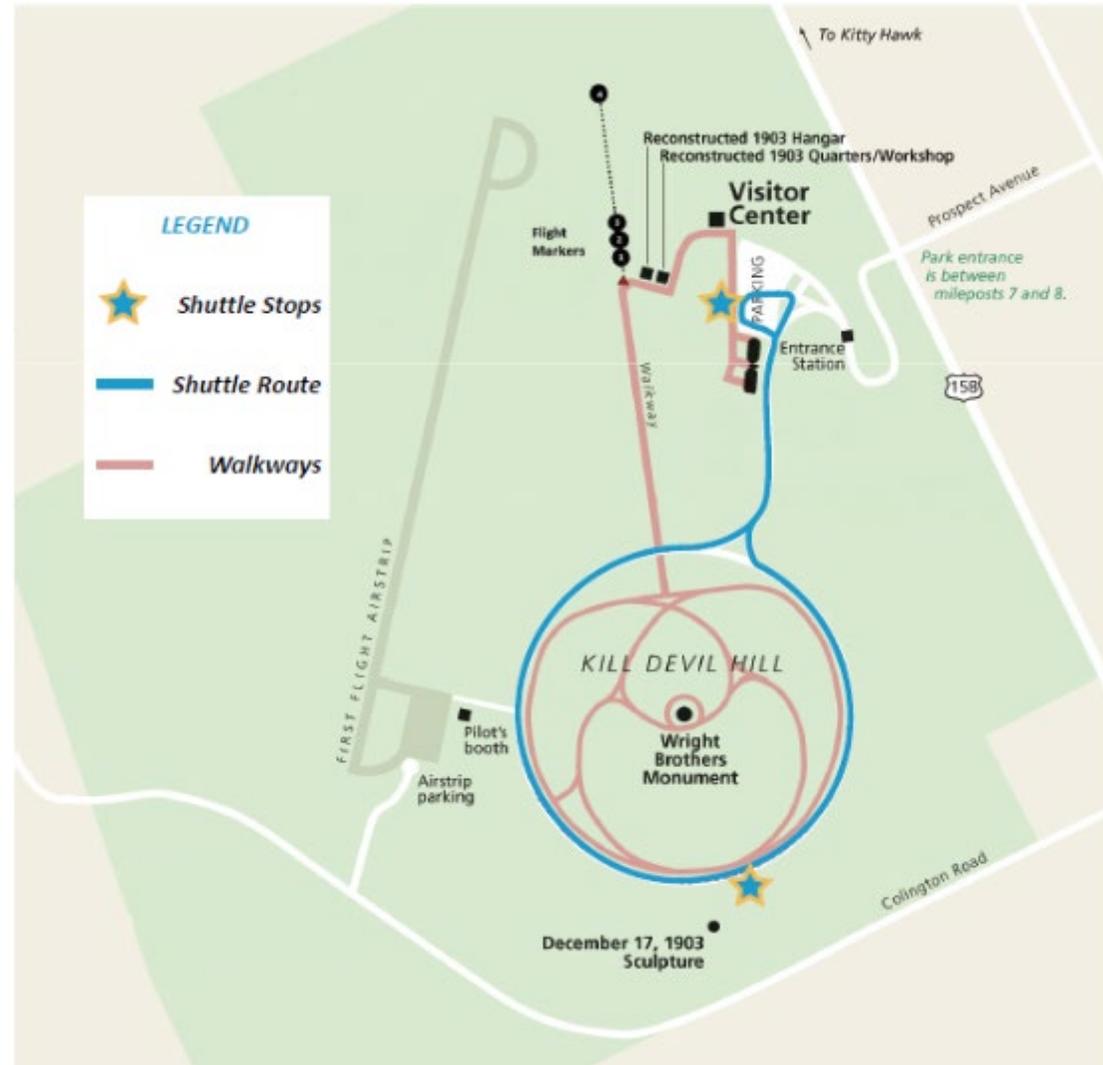
Deployment 3: Wright Brothers National Memorial

- 12 weeks
- 2200 passengers (1st 8 weeks w/COVID capacity restrictions)
 - In 516 trips
- 226 survey responses



Wright Brothers National Memorial

- Dates: April 20-July 16, 2021
- Demo length: 1.2 mi
- Maximum speed: 10-12 mph
- Available for all visitors
- COVID precautions
 - Same Household vs. Different Household
 - Open windows
 - Masks
 - Cleaning protocols



Wright Brothers National Memorial

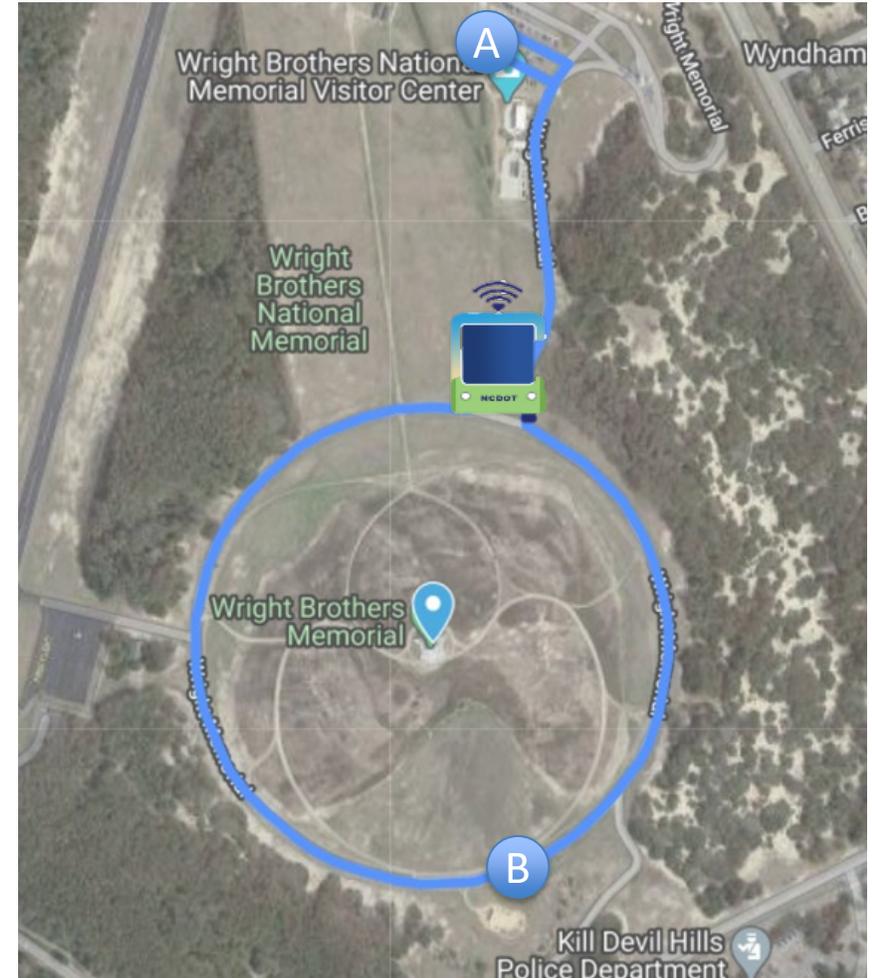
Shuttle Tracking



» NCDOT Website & Live Tracking QR Code



» Survey QR Code



Some Early Lessons Learned/Best Practices

Lessons Learned

- Keep the grass cut close to the road
- CASSI in manual mode moves slower than a pedestrian
- Standing water and precipitation create problems
- Extensive field testing of both limited mobility loading areas and pedestrian crossings are key
- Finding a storage location is always a challenge

Best Practices

- Close on-site observation of operations for first week or so
- Maintain a shared deployment diary between partners
- Weekly project team meetings



Attention Pedestrians
We are testing an autonomous shuttle in the Park through July. The shuttle can not divert off of its mapped track.
It will slowly follow pedestrians until they step off the road shoulder. We are sorry for the inconvenience.



Next Deployment
Location??





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Questions

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Multimodal Innovations Webinar Series



July 2021

Tech Showcase (Tentative) – Updates on New Technologies in the Mobility World