MAY 26, 2020

GOVERNOR'S ADVISORY COUNCIL ON CONNECTED & AUTOMATED VEHICLES

Setting Our Vision and Advancing an Innovation Alliance

DESTINATIONCAV

DEPARTMENT OF TRANSPORTATION

WELCOME & INTRODUCTIONS

Margaret Anderson Kelliher, Co-Chair
Commissioner, MnDOT

Phil Magney, Co-Chair
CEO and Founder, VSI Labs

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MEETING GOALS

1. Understand how the CAV industry is reacting to COVID-19 and pivoting to the future
2. Learn how the council can more directly support the state's CAV Office goals
3. Discuss an innovation alliance model and subcommittees.

NATIONAL TRENDS IN CAV & AUTOMATION

NATIONAL HIGHLIGHTS ON CAV ADVANCEMENTS & HOW ORGANIZATIONS ARE USING AUTOMATION TO SUPPORT SAFETY AND PUBLIC HEALTH

PHIL MAGNEY, VSI LABS

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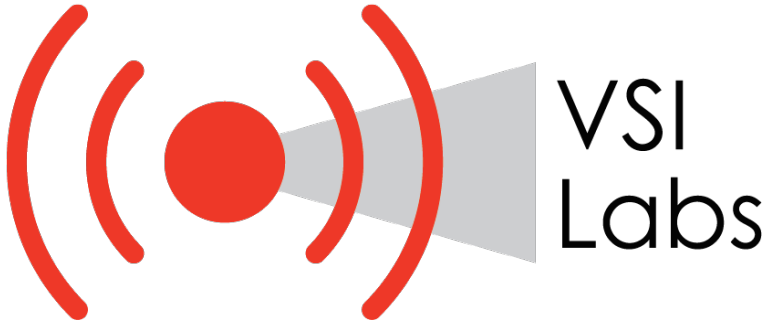
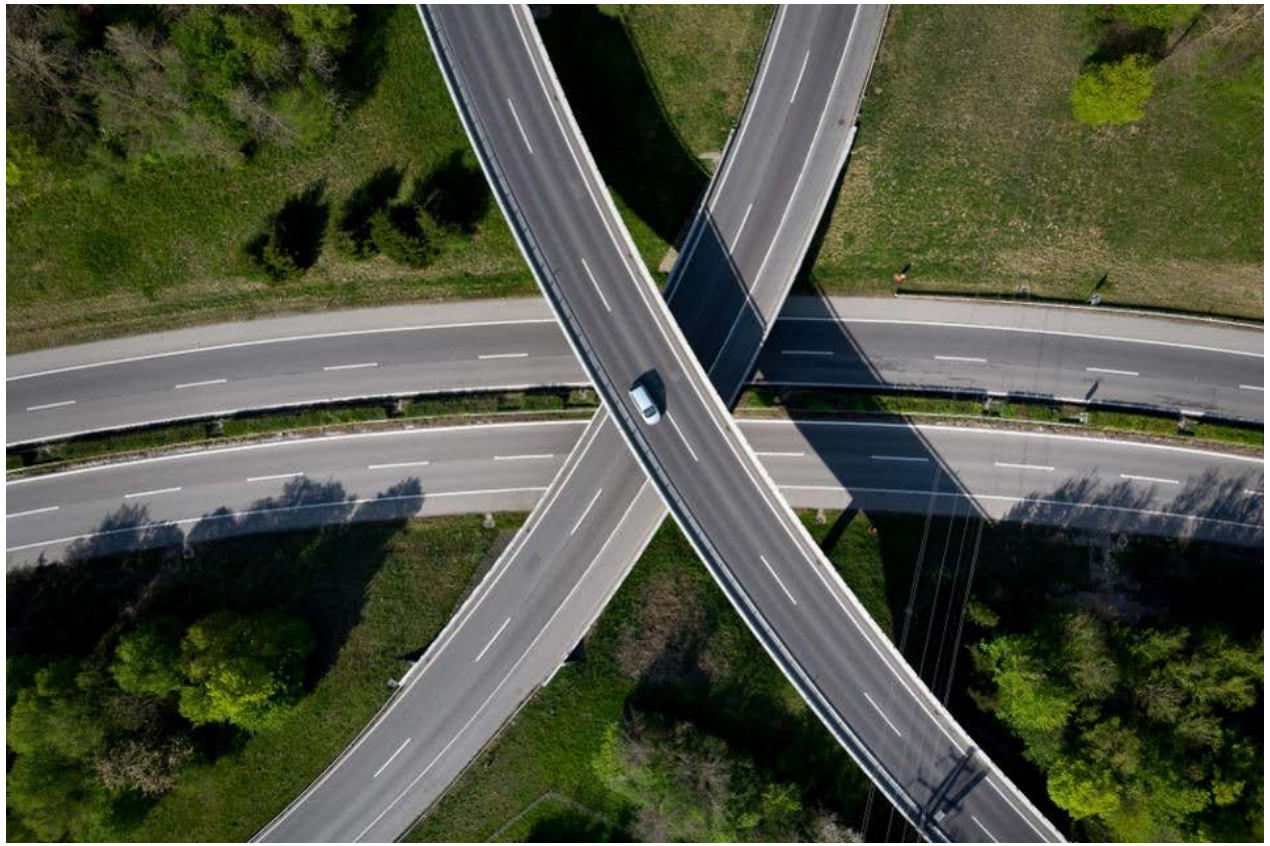


VSI Labs

The State of CAV in a COVID Era

Where do we go from here?



GETTY IMAGES

Opening Remarks

- This is a fantastic time to re-evaluate what you are doing!
- Reinvent yourselves – new products, new systems, new workflows
- Becoming more efficient – and learning how to make more with less!
- Some CAV sectors will accelerate or will be delayed!

What is VSI Doing?

More Applied Research

Test & Demonstration	POC Testing	Data Collection	Validation Services
Sponsored Build	Component Testing	Geocoded Metadata	Functional Validation

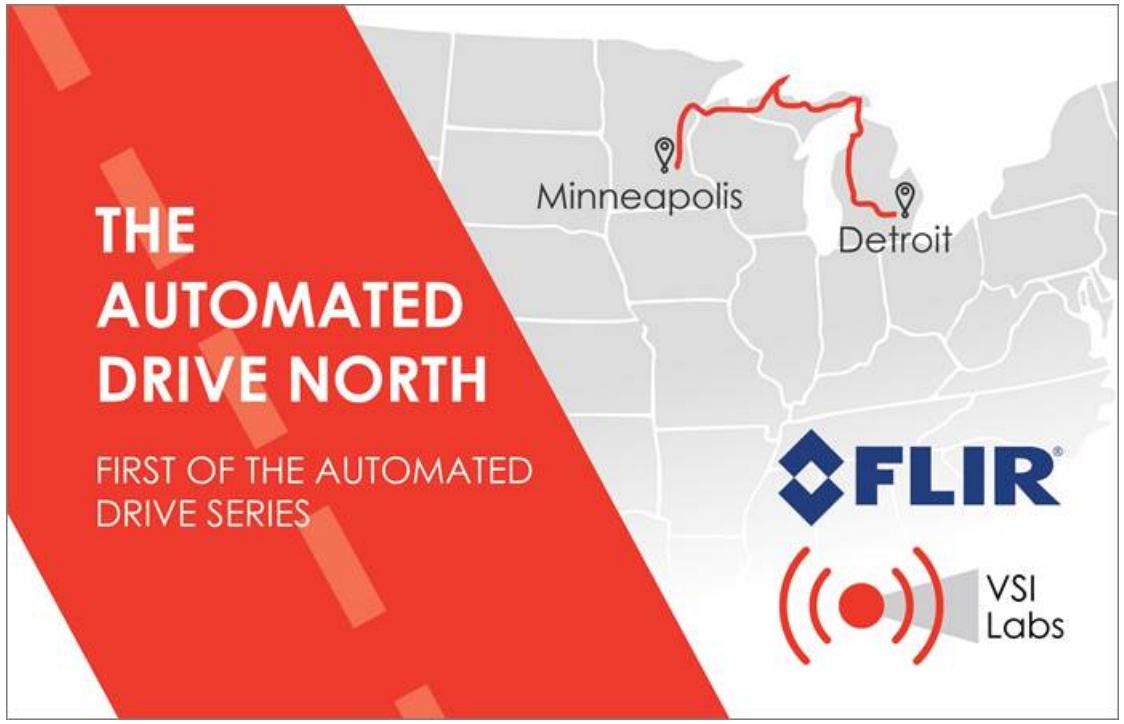
THE **AUTOMATED** DRIVE SERIES

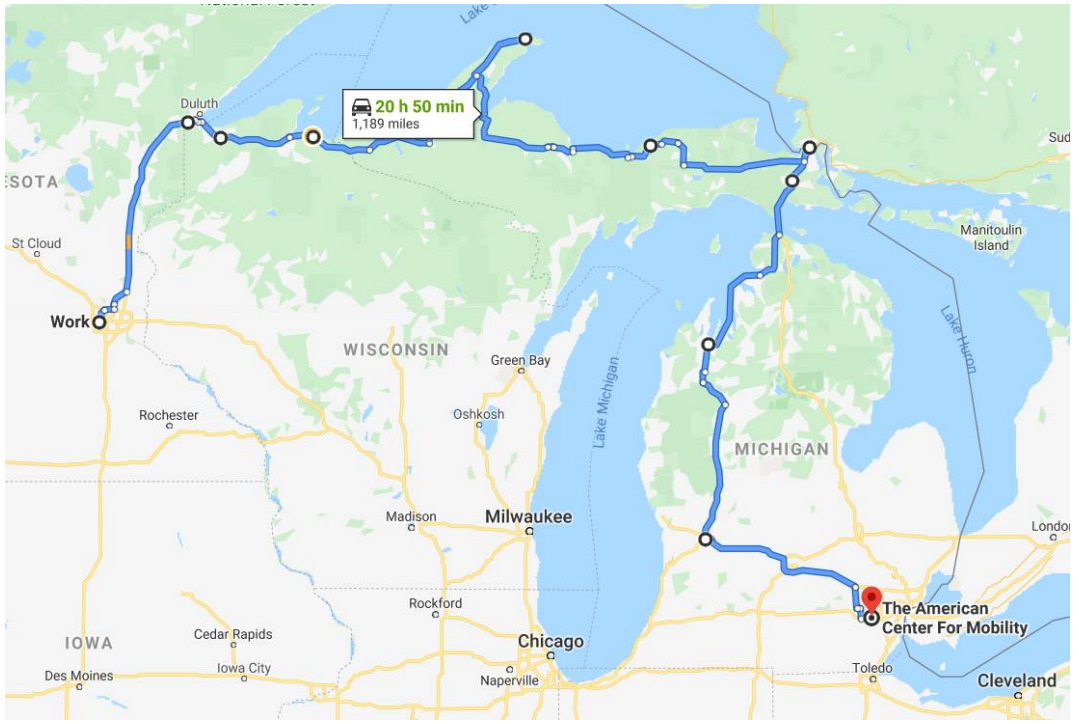
4 Drives | Coast-to-Coast | Diverse Conditions

Promote your AV/ADAS technologies in a novel and practical way in an era where traditional conferences and expositions are limited.

VSI Labs

The Automated Drive North – July 12th



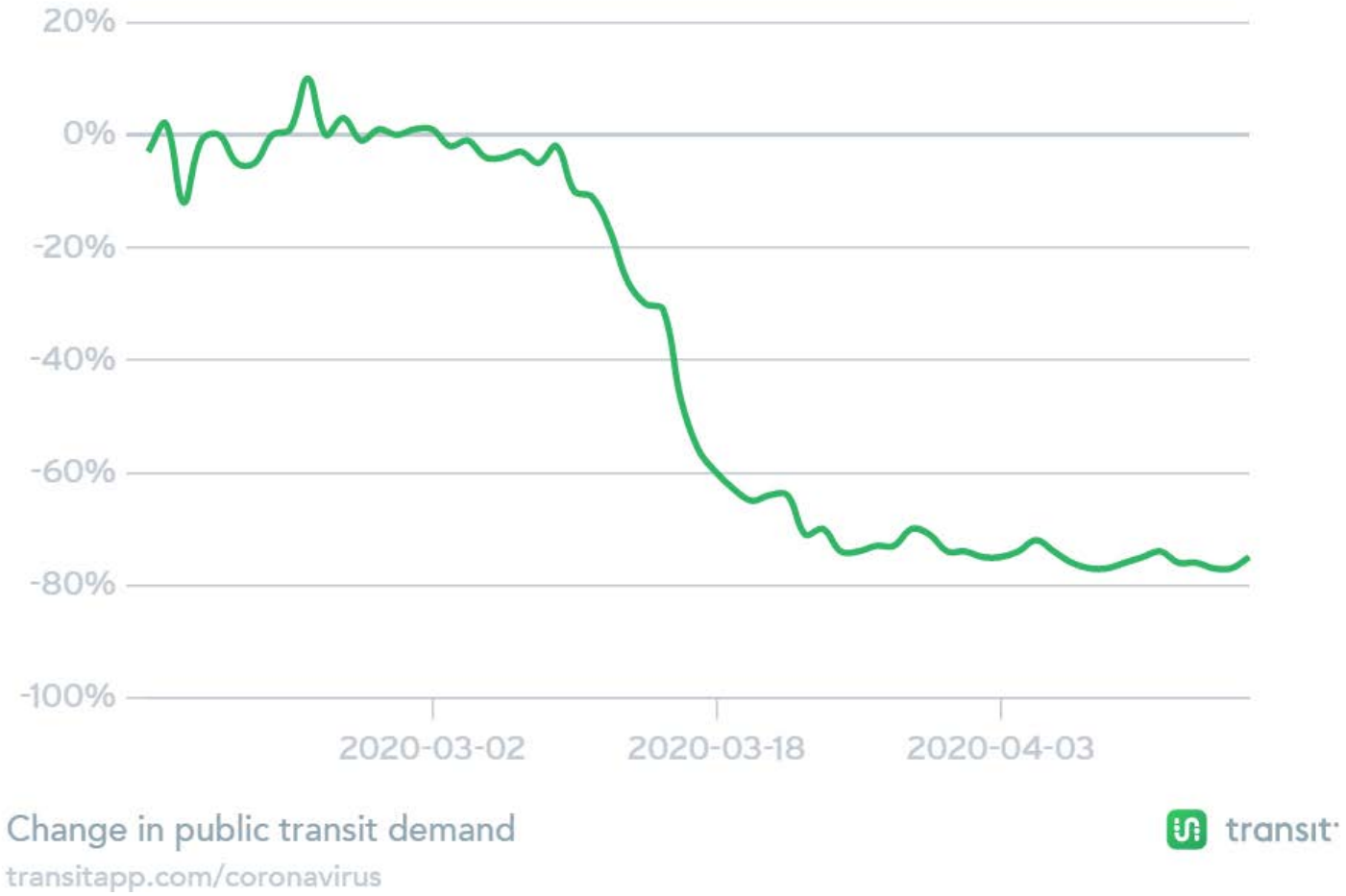


The Impact of COVID-19 on CAV

The State of CAV – COVID Era

- Covid-19 is set back for the developers of full stack AVs
- The automotive sector is hit particularly hard
  - Major OEMs are hurt bad financially leading to big R&D reductions
  - Major OEMs will resume their CAV work to the extent their balance sheets permit
- Many of the tech startups will run out of money
- No new money coming in (the big funders are reeling – Softbank!)
- Shared Mobility is suddenly out of favor
- This pandemic may reduce overall miles driven per year

Public Transit Declines



According to app company Transit, public transit demand is down 75% compared to normal. Despite this, many individuals who are deemed essential workers, and others who need groceries or medical care must rely on public transit amidst the pandemic. The nature of these vehicles means riders must stay in close proximity in a confined space.

Unmanned Delivery

Nuro made timely news earlier this month when it was approved to test its driverless delivery robots on public roads in California

Beijing-based Neolix is repurposing its tiny self-driving vans to deliver medical supplies and food to hospitals throughout Wuhan,

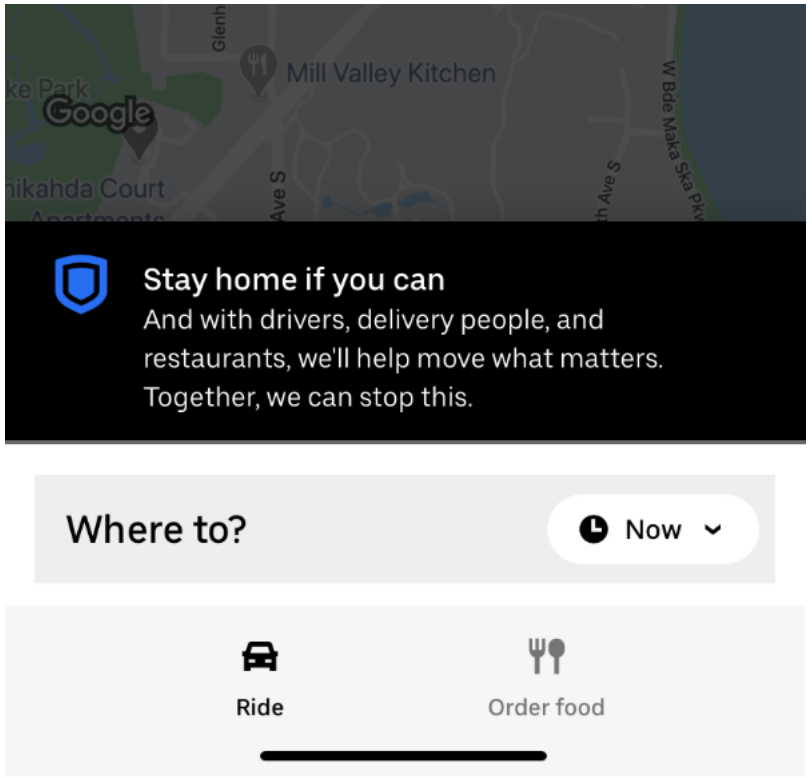
French company NAVYA has partnered with Beep and the Jacksonville Transportation Authority to repurpose their self-driving vehicles to transport COVID-19 test samples for the Mayo Clinic.

Delivery robots have become an important aspect of mobility during the pandemic, eliminating contact between individuals, and reducing the burden of delivery programs that rely on human drivers!

Shared Mobility

Shared mobility has been radically affected by COVID-19. Ride hailing behemoths Uber and Lyft have decreased rides significantly

Micro mobility has seen an even more dramatic impact in the wake of COVID-19. 99% of electric scooters deactivated/removed from cities.



Screenshot from Uber app on April 15

On-Going on CAV Challenges

Automated Driving vs. Autonomous Cars

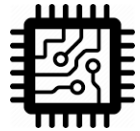
Blame the Human !

Blame the Computer !

Shrinking Gap

Human Drivers

The New ADAS



Machine Drivers

Automated Mobility on Demand

Level 1 Level 2 Level 3 Level 4 Level 5

Limitations of AVs in Poor Weather?

Sensors Fail

- Camera & Lidar fail quickly
- Radar soon fails

Infrastructure Fails

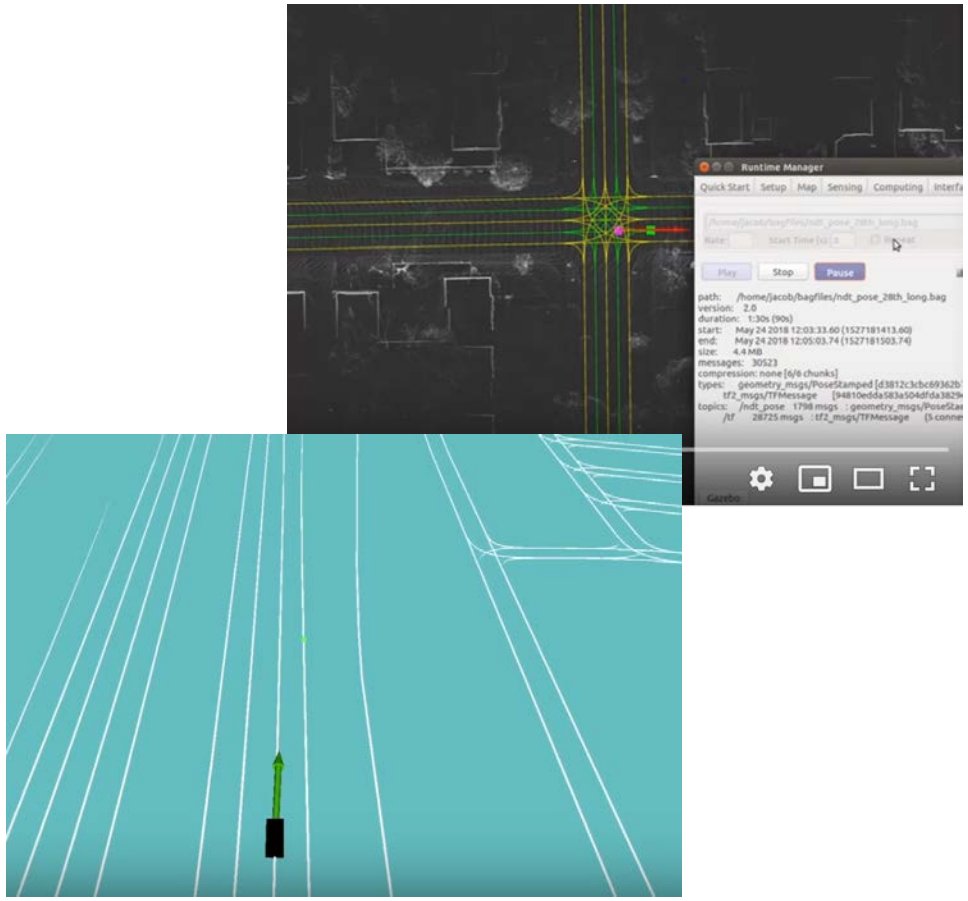
- Lanes lines covered
- Localization assets hard to recognize if they are covered in snow

What Does it Take?

- Better localization
- V2I – through embedded cellular, DSRC
- Virtual Infrastructure – Precision Maps (lanes models, intersections, and other metadata)
- Low Grip Algorithm

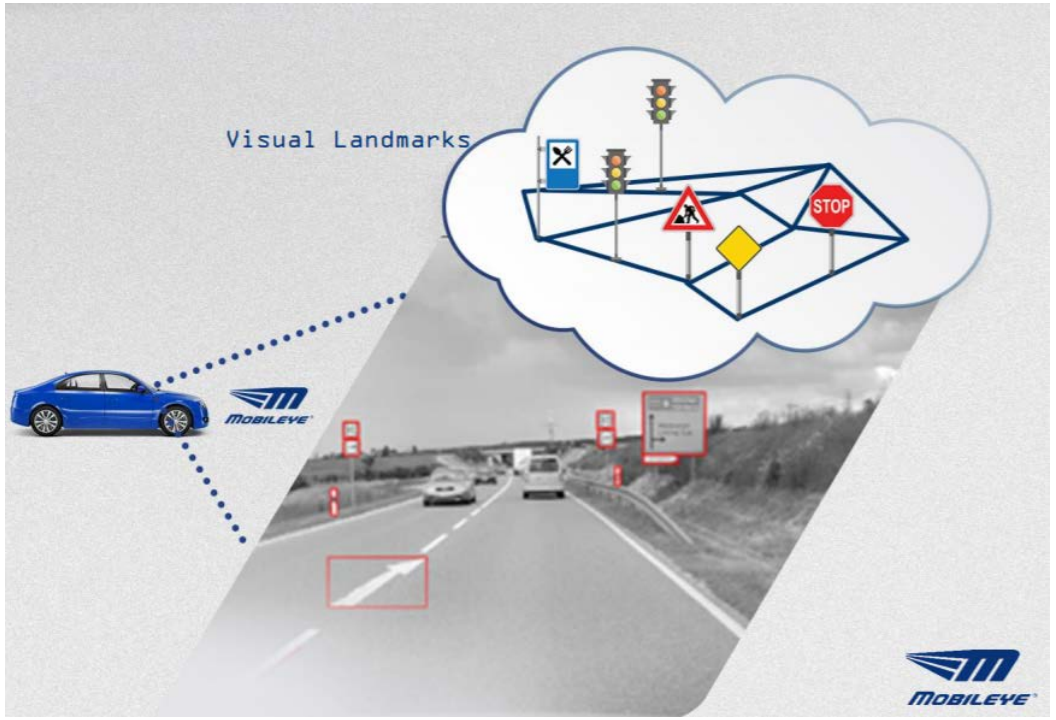
What About HD Maps

- Precision maps are like a virtual infrastructure!
- Precision maps have lane lines, so the self-driving car knows where to be even in the snow!
- Precision maps are vital to multilane highways and intersection traversals
- Precision maps give the self-driving car the intelligence it needs to be safe!



How to Keep the Data Fresh

- Mapping data are always changing
  - Temporary lane closures or detours
  - Changes to the infrastructure (bridges, landmarks, poles, lights)
- How to detect changes, collect, then validate those changes
  - Requires fleets to crowd source
  - Requires connected vehicles
  - Requires standardization of message sets

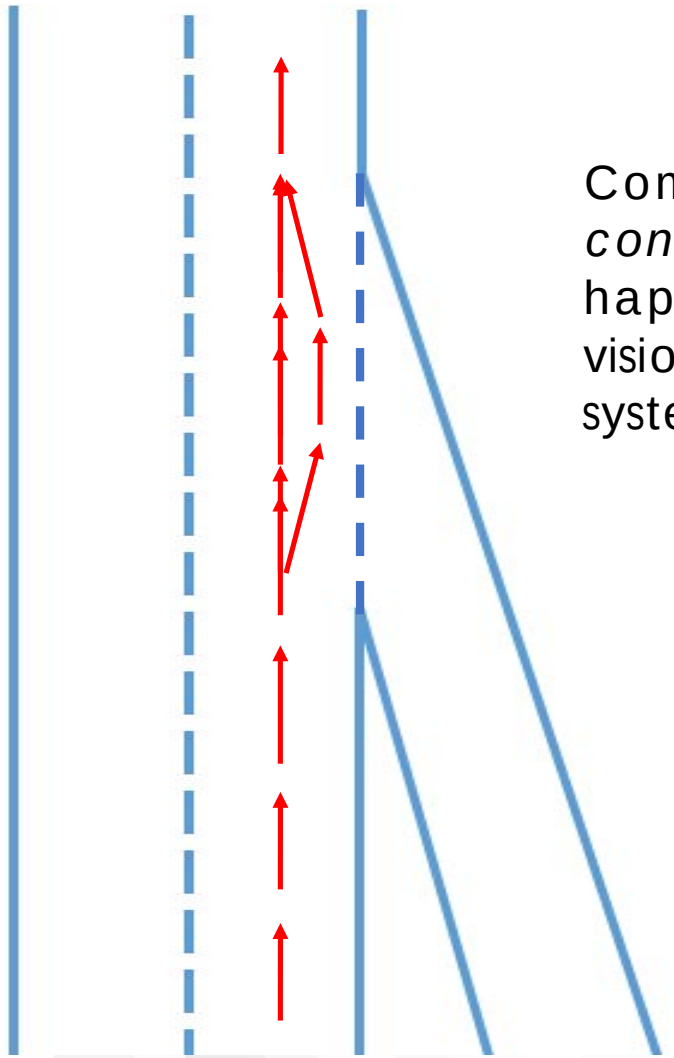


How Do Cars See Lanes

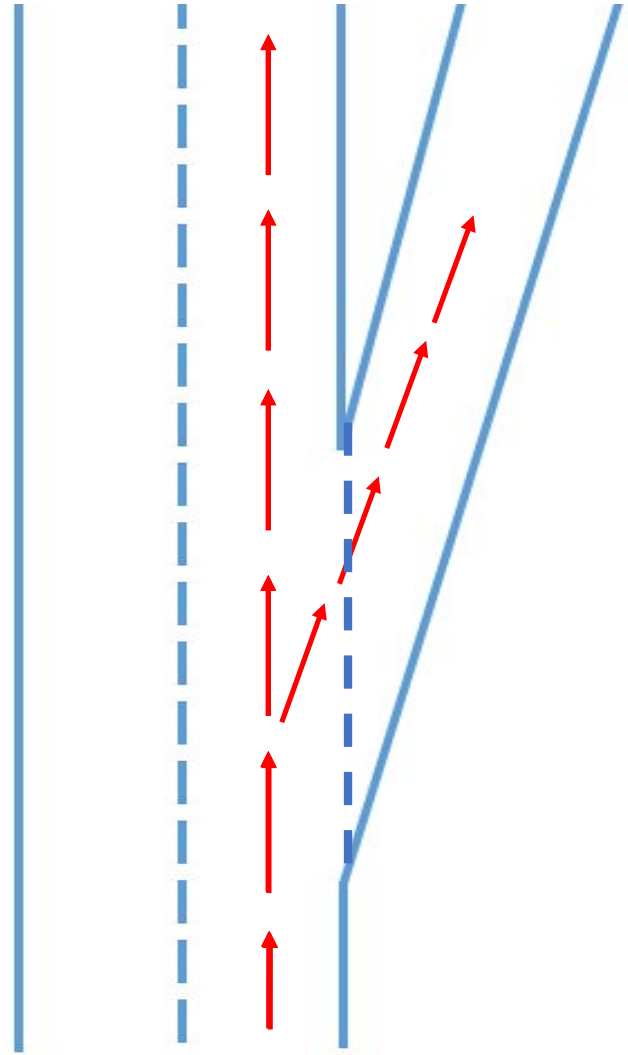
Sensitivity to Lane quality

- Feature-based lane detection
  - The basis for lane departure warning or correction (Hough, Canny Edge)
- Model-based lane keeping
  - Models the lane geometry (RANSAC)
- AI-Based lane keeping
  - Based on trained inference model

Limitations of Vision-based Lane Keeping



Common *boundary conditions* happen often with vision based ADAS systems



Closing Remarks

- Weak companies pre-COVID are struggling
- COVID is forcing adjustments:
  - The benefit of clean quite cities
  - Teleworking
  - Mobility
  - No Minnesota State Fair 
- Tech-based AV development will do better than traditional auto companies
- COVID will lead to great innovations and some CAV segments will do better than others

Questions?

Contact

Phil Magney

Founder & Principal Analyst

(952) 215–1797

phil@vsi-labs.com

Visit our website:

https://www.vsi-labs.com

Follow us on social media:

@VSILABS @vsilabs @VSI Labs @VSI_Labs

QUESTIONS & DISCUSSION

ROCHESTER AUTONOMOUS SHUTTLE PROJECT & EASYMILE'S NATIONAL WORK

SHARAD AGARWAL, EASYMILE

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GOVERNOR'S ADVISORY COUNCIL ON CONNECTED AND AUTOMATED VEHICLES

May 26th

EasyMile brings driverless vehicle solutions for people and goods to life with leading technology that provides a real service

DEPARTMENT OF TRANSPORTATION

AGENDA

1. EasyMile Background
2. Flagship locations
3. Rochester Project
4. COVID-19 and the use of CAVs

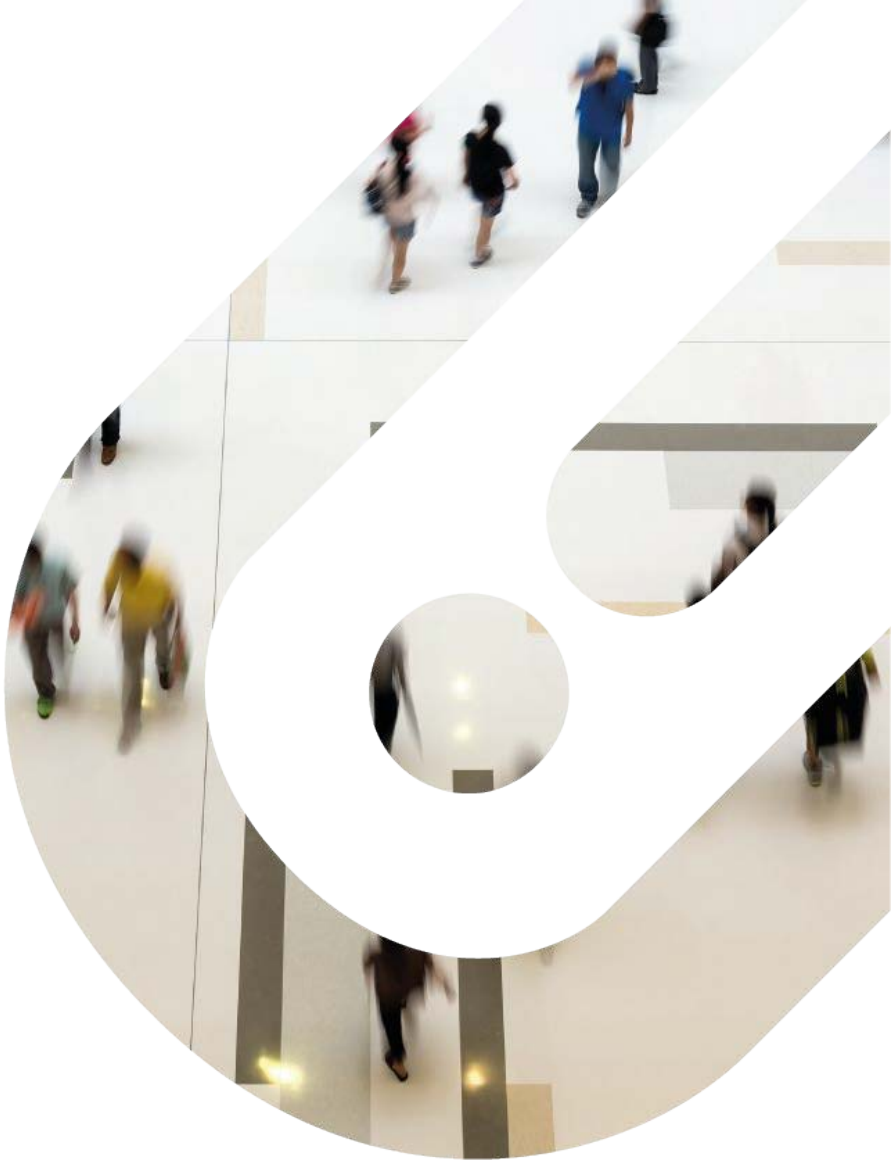
SHARAD AGARWAL

SENIOR VICE PRESIDENT - EASYMILE

- Born Fridley, MN
- Irondale High School Class of ‘95
- University of Minnesota Class of ‘00
  BSB Finance
- 1st Job out of college at General Mills
- 15 Years in passenger transportation
- #1 Minnesota Vikings Fan

EASYMILE BACKGROUND

EasyMile brings automated vehicle solutions for people and goods to life with leading technology that provides a real service



EASYMILE AT A GLANCE

Since
2014

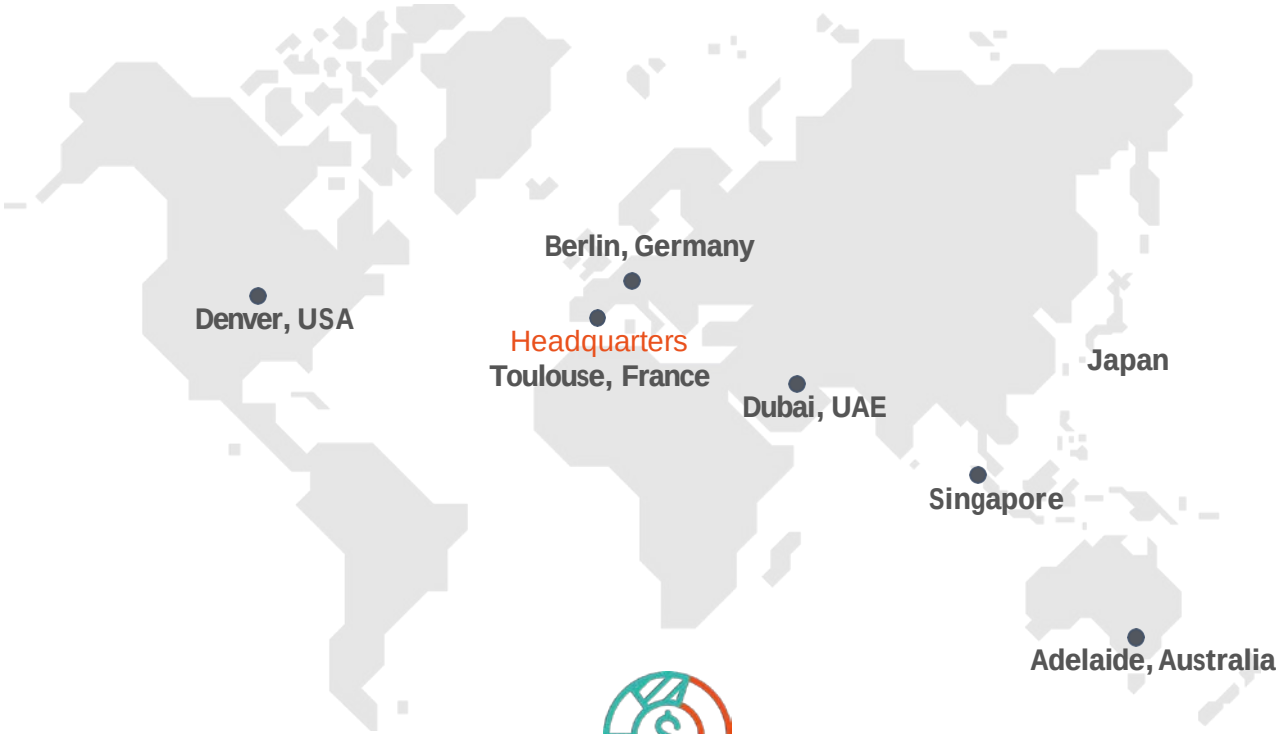
30+ PhDs

220+

Leader
in R&D

7
locations

22
nationalities



Shareholders

Founders, Continental, Alstom and Bpifrance

EZ10 AUTOMATED SHUTTLE

Driverless and electric shuttle

6

6 seats with seatbelts

16h autonomy, 12h with A/C

ADA Compliant

Pre-mapped network of roads

150
Shuttles worldwide

SPEED LIMIT 12

EZ10 maximum speed

SPEED LIMIT 25

Other vehicles' maximum speed

>300
Deployments
In 30+ countries

ez10

MAIN PRINCIPLES OF AUTONOMOUS DRIVING

Localization

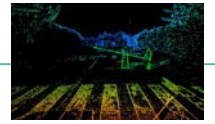
Using all the available data from the different sensors in a fusion algorithm, the vehicle knows its position and the accuracy of it at all times. Any potential deviation will safely slow down or stop the vehicle.

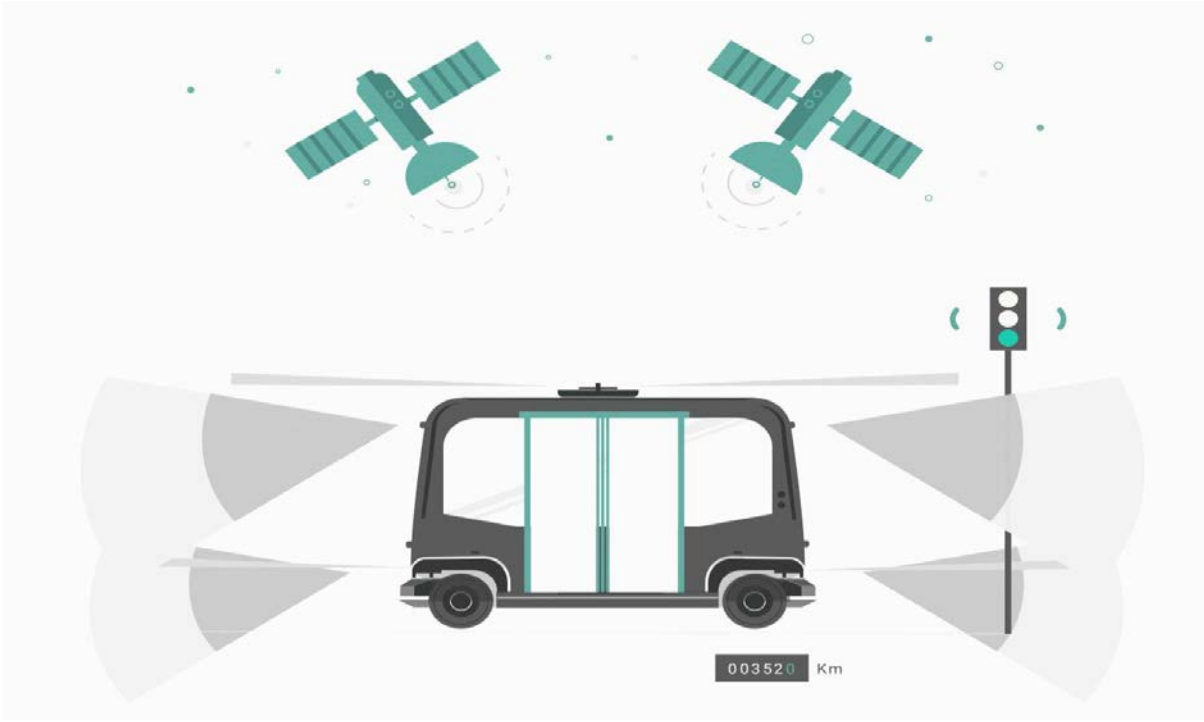
Navigation

The vehicle can be programmed to a site map, even with a network of potential trajectories, with all elements triggering specific behavior (e.g speed areas, pedestrian crossings etc.). The vehicle follows the path smoothly with pre-defined behavior.

Perception

If an obstacle appears, the vehicle's sensors detect it and trigger appropriate behavior, slowing down, overtaking or stopping. When the obstacle is avoided, the vehicle proceeds.





NATIONAL HIGHWAY TRANSPORTATION SAFETY AUTHORITY (NHTSA)

- The EZ10 is imported under Box 7a which requires NHTSA permission to operate within the US.
- EasyMile and partners have successfully imported 30 EZ10s.
- Recently, on February 22nd, a passenger fell off her seat in Columbus, OH as the vehicle came to a stop whilst traveling at 7.1 mph
  - NHTSA decided to stop all passenger boardings while a review could be conducted.
  - Vehicles were permitted to continue operating after a comprehensive review from the DOT.
- EasyMile is now back up and running across the US with the installation of seat belts and additional messaging around the vehicle operations.

NHTSA
NATIONAL HIGHWAY TRAFFIC SAFETY ADMINISTRATION

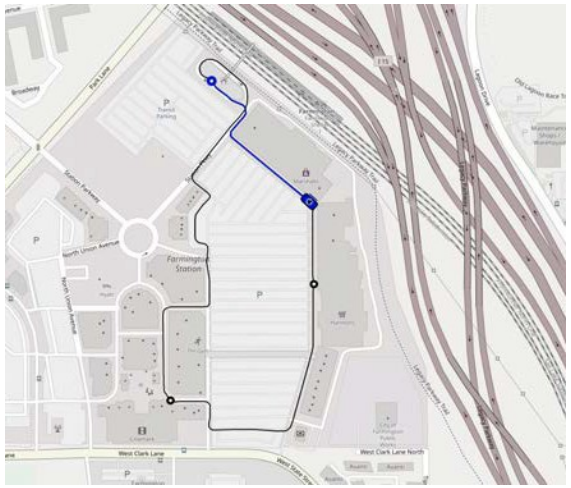
Flagship locations

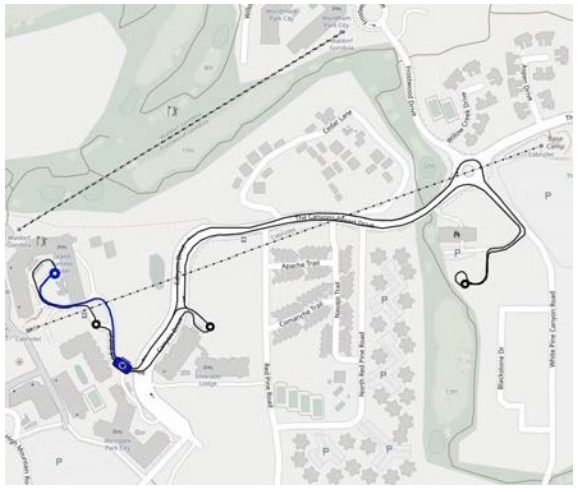
- *Varioususe casesincluding, Department* of Transportations, Airports, Fortune 500 firms and University Campuses

UTAH DEPARTMENT OF TRANSPORTATION

10 venues over 12 months around Salt Lake City with different use cases and customer types: skiing resorts, business parks, university campus, hospital, malls.

Place	*Various Locations Around the State of Utah, USA*
Customer and Client URL	*Utah Department of Transportation. http://www.avshuttleutah.com/*
Environment	*Private and Public Roads*
Description of the project scope	*Mixed Traffic with Pedestrians, Bikes and Motorized Vehicles*
Route length	*Average 1 mile*
Make, Model and Number of shuttles used	*One EasyMile EZ10 Gen-2*
Project Duration - including passengers carried,	*18 months project, has been ongoing since March 2019. 750 riders per month.*
Average temperatures and weather encountered	*The highest average temperature is 89.4° and the lowest average temperature is 17.1°F. Weather includes snow, rain, wind, fog, hail*

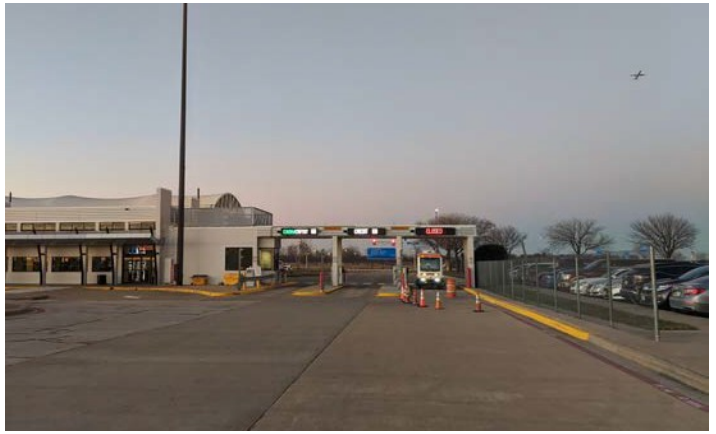


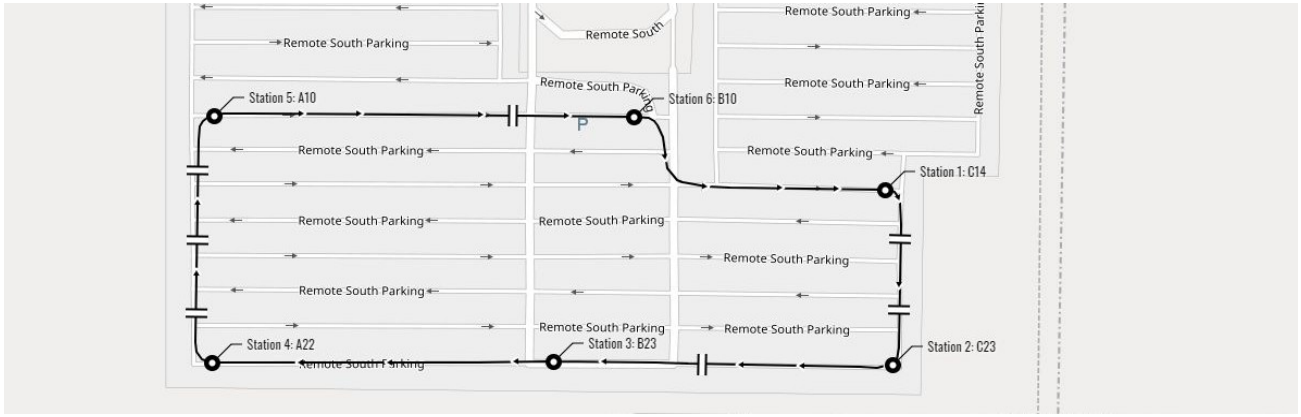


DALLAS FORT WORTH AIRPORT, TEXAS

Dallas Fort Worth International Airport (DFW) has contracted EasyMile to provide a driverless shuttle service transporting passengers in the Remote South Parking lot in order to provide a seamless connection with a shuttle service to the airport terminal. The service is being provided from December 2019 to June of 2020 and is operating from 7am to 3pm on weekdays. DFW is using this first pilot as an opportunity to learn about the driverless technology and understand potential additional applications throughout the airport. Future opportunities at DFW include additional passenger transport locations in addition to baggage transport airside or landside.

Customers and Client URL	*DFW - www.dfwairport.com*
Environment	*Private parking lot -landside*
Description of the project scope	*Mixed Traffic with Pedestrians and Motorized Vehicles*
Route length / Number of stops	*0.75 mile with 6 stops*
Make, Model and Number of shuttles used	*One EasyMile EZ10 Gen-2*
Project Duration, hours of service - including passengers carried	*6 month first phase 7am to 3pm. Approx. 50-100 passengers per week*
Average temperatures and weather encountered	*The highest average temperature is 96° and the lowest average temperature is 30°F. Weather includes rain, wind, fog, hail.*



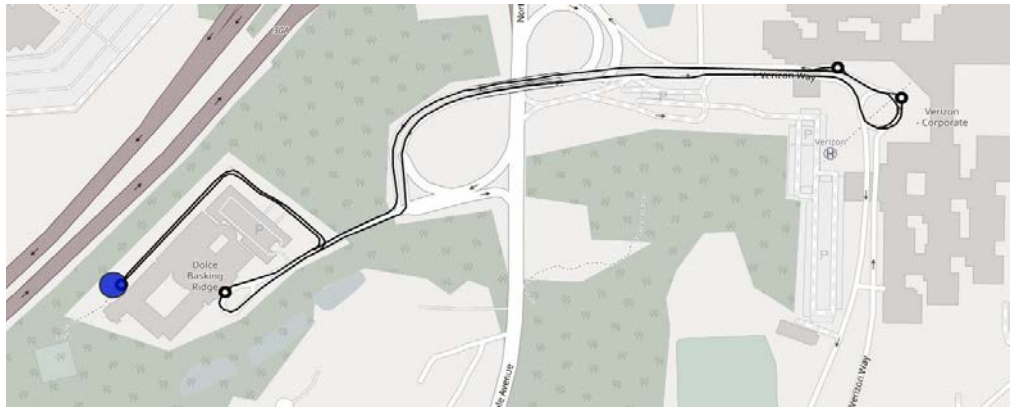


Reference: Jodie Brinkerhoff, Vice President, Innovation, jbrinkerhoff@dfwairport.com

VERIZON, BASKING RIDGE CAMPUS, NEW JERSEY

The EZ10 shuttle services Verizon employees from the Verizon Employee Hotel to the Corporate Campus working with their current shuttle service provided on the campus. This project is an exciting R&D opportunity of between Verizon and EasyMile, using the EZ10 as a mobile 5G test bed.

Customers and Client URL	*Verizon - www.verizon.com*
Environment	*Private campus*
Description of the project scope	*Mixed Traffic with Pedestrians, Bikes and Motorized Vehicles*
Route length / Number of stops	*1.1 mile with 3 stops*
Make, Model and Number of shuttles used	*One EasyMile EZ10 Gen-3*
Project Duration, hours of service	*Long term relationship* *Monday to Friday, 10am to 3pm.*
Average temperatures and weather encountered	*The highest average temperature is 85° and the lowest average temperature is 19°F. Weather includes rain, wind, fog, hail, snow.*

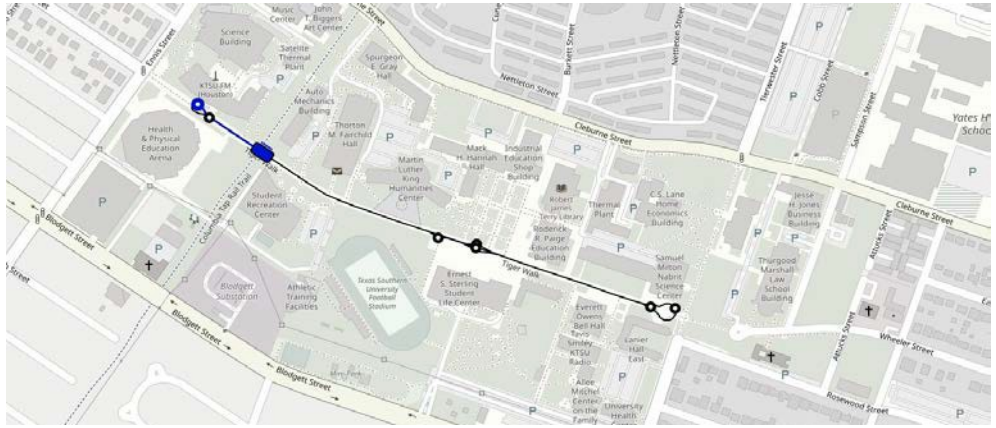


HOUSTON METRO, TSU, TEXAS

Texas Southern University, METRO, First Transit, Houston-Galveston Area Council and EasyMile started the region's first Shared Autonomous Shuttle in June 2019.

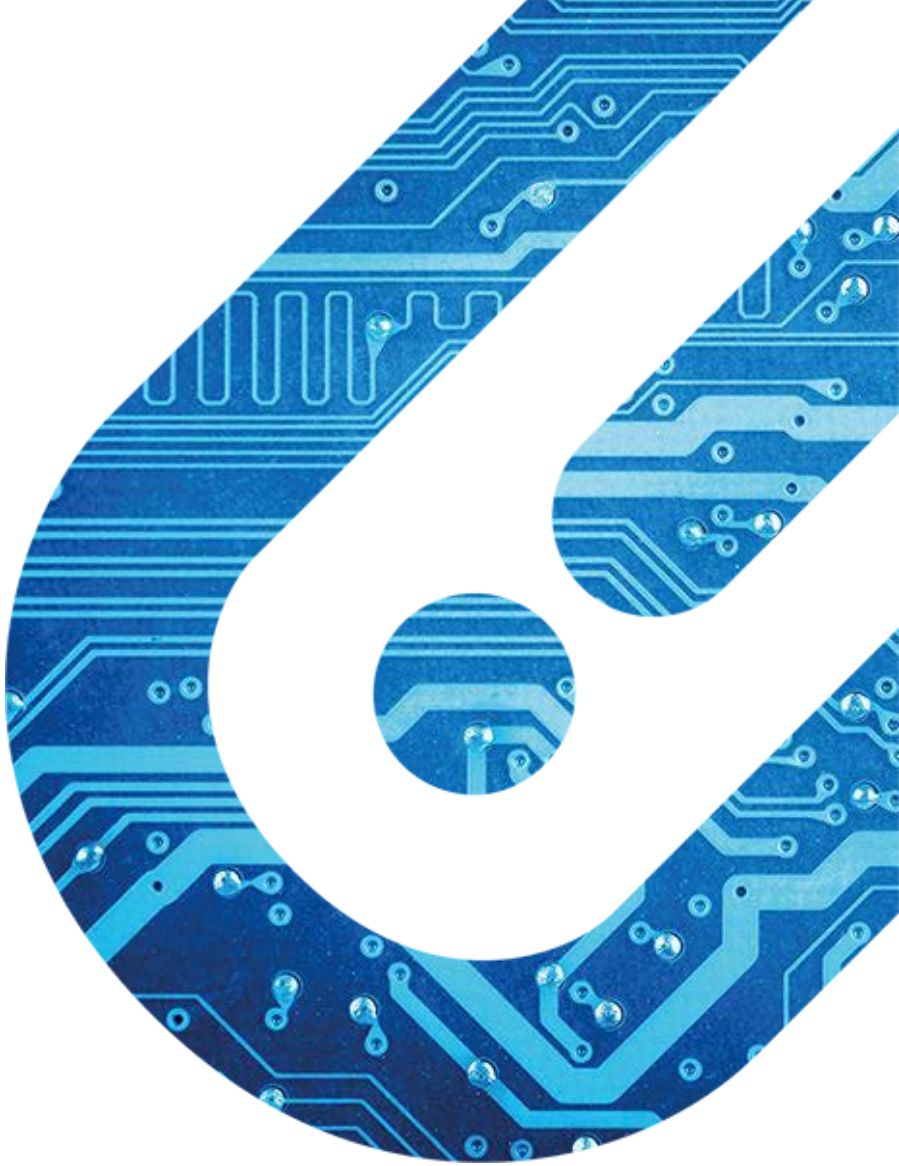
The University District Circulator in which a driverless EasyMile SAV shuttle travels on the Tiger Walk is a one-mile pedestrian walking loop, providing connections to multiple points and buildings on campus for students and faculty.

Customers and Client URL	*Houston METRO - https://www.ridemetro.org/*
Environment	*University campus*
Description of the project scope	*Mixed Traffic with Pedestrians, Bikes and Motorized Vehicles*
Route length / Number of stops	*1 mile with 6 stops*
Make, Model and Number of shuttles used	*One EasyMile EZ10 Gen-2*
Project Duration, hours of service, ridership	*Phase 1 was 6 months - extended to 1 year.* *Phase 2 is for an additional year with options* *7am to 3pm* *1,000 Passengers per month*
Average temperatures and weather encountered	*The highest average temperature is 93° and the lowest average temperature is 44°F. Weather includes rain, wind, fog, hail.*



Rochester Shuttle Project

A first for the industry - the evolution of technology.
Follow up Winter Testing



NOT OUR fiRST TIME IN THE LAND OF 10,000 LAKES

The purpose of the winter testing was to observe and assess the operation of the EasyMile EZ10 through a series of operational scenarios conducted on the low volume segments at MnROAD.

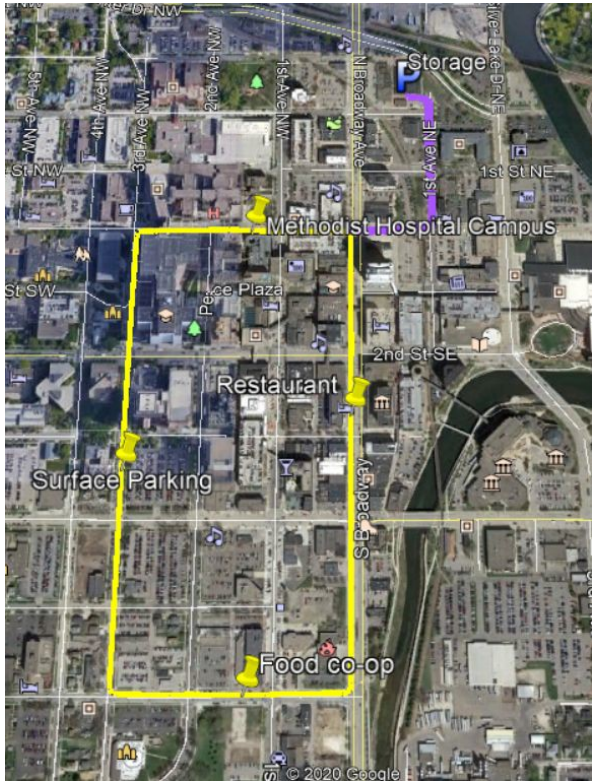
Key project goals related to the Demonstration are the following.

1. Understand vehicle performance in winter snow / ice / salt conditions.
2. Promote awareness and the benefits of autonomous vehicle technology to local stakeholders, officials and the public through demonstrations.
3. Obtain national exposure and increase Minnesota's influence and visibility on advancing autonomous vehicles.
4. Prepare for autonomous bus assessment on public roadways and bus rapid transit facilities.

As a result EasyMile are the only autonomous vehicle company in the world who has conducted successfully such thorough winter testing.

ROCHESTER PROJECT INTRODUCTION

- 2 EZ10 Gen3s will connect Methodist Hospital with hotels, shops, restaurants, and parking for 12 months.
- Operations schedule: to be finalized
- The site involves mixed traffic, signalized intersections, and Minnesota weather!
- NHTSA approval will be required
- Project will leverage MnDOT's EZ10 winter testing experience from 2017 project
- Project can show potential for applying AVs in transit setting
- Project will identify any infrastructure improvements that might be necessary for AVs while ensuring safety on public roadways.



EasyMile during COVID-19

Focusing on our people, our riders and ourjourneys

OUR PEOPLE

Today, EasyMile recommends that our customer service ambassadors (CSA) wear masks or face coverings when within six feet of others while at work.

Furthermore, whenever possible, EasyMile recommends disinfecting seats, public areas, buttons, handles, and other locations they and their riders interact with. Disinfectants for use against SARS-CoV-2 can be found here. Frequency of cleaning cycle would be dependant on number of people carried.

EasyMile will continue to follow the guidelines of the state and local authorities wherever we and our partners operate.

"EasyMile is committed to protecting our staff and passengers, as well as doing our part in the broader community to help slow and stop the spread of COVID-19"

OUR RIDERS

EasyMile recommends that our operating partners require riders wear masks or face coverings when within six feet of others while onboard the EZ10.

With the current seat configurations, EasyMile recommends no more than four people in the vehicle at one time - stickers could be placed on the seats indicated not to be used and enforced by the operator. EasyMile also recommends that the middle seats, or perch seats are not used to address social distancing requirements.

Exceptions to this rule are if families, greater than four people, all living in the same household. These groups are permitted to ride together, as long as they don't exceed the maximum capacity of the EZ10 today with or without a customer service ambassador on board.

OUR JOURNEYS

EasyMile recommends our operating partners limit passenger interaction with buttons by:

- Leveraging our Customer Service Ambassadors to manage the door openings and ramp deployment when needed.
- Stickers on doors encouraging riders to touch buttons (where applicable)
- Setup a timer with automatic door opening when reaching stations and automatic door closing/departure after a certain time at station.
- Operations could be focused on shorter, more personalized and individualized experience.

EasyMile will always follow transportation recommendations from within our industry and leverage our international experience sharing best practice from around the world.

EASYMILE GIVING BACK

Westminster Food Bank Project

ALTERNATIVE EZ10 USE

EasyMile are using the EZ10 to connect a grocery store to a community food bank hauling supplies for the residents of Westminster, CO.

Here we are utilizing our technology with minimal human interaction as the shuttle runs without an operator on board.

Customers and Client URL	*City of Westminster, CO.* https://www.cityofwestminster.us/
Environment	*Public Road, Private Roads*
Description of the project scope	*Mixed Traffic with Pedestrians, Bikes and Motorized Vehicles*
Route length / Number of stops	*0.75 miles with 2 stops*
Make, Model and Number of shuttles used	*One EasyMile EZ10 Gen-2*
Project Duration, hours of service	*Mornings Monday through Saturday*
Average temperatures and weather encountered	*The highest average temperature in May is 74° and the lowest average temperature is 42°F. Weather includes rain, wind, fog, hail, snow.*

THANK YOU

Connect with us:

#EasyMile

DESTINATIONCAV

DEPARTMENT OF TRANSPORTATION

QUESTOINS & DISCUSSION

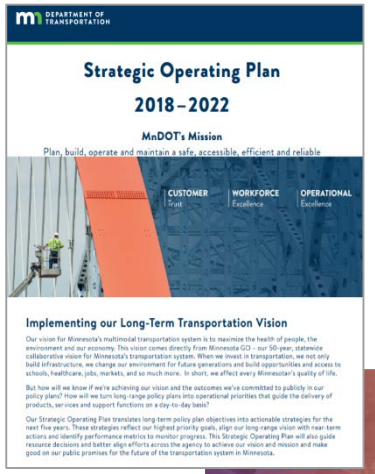
MNDOT CAV-X STRATEGIC PRIORITIES

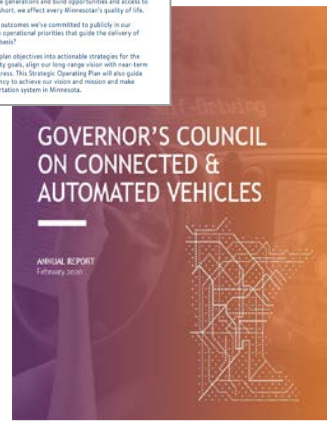
COVID-19 IMPACTS & OTHER PROGRAM UPDATES

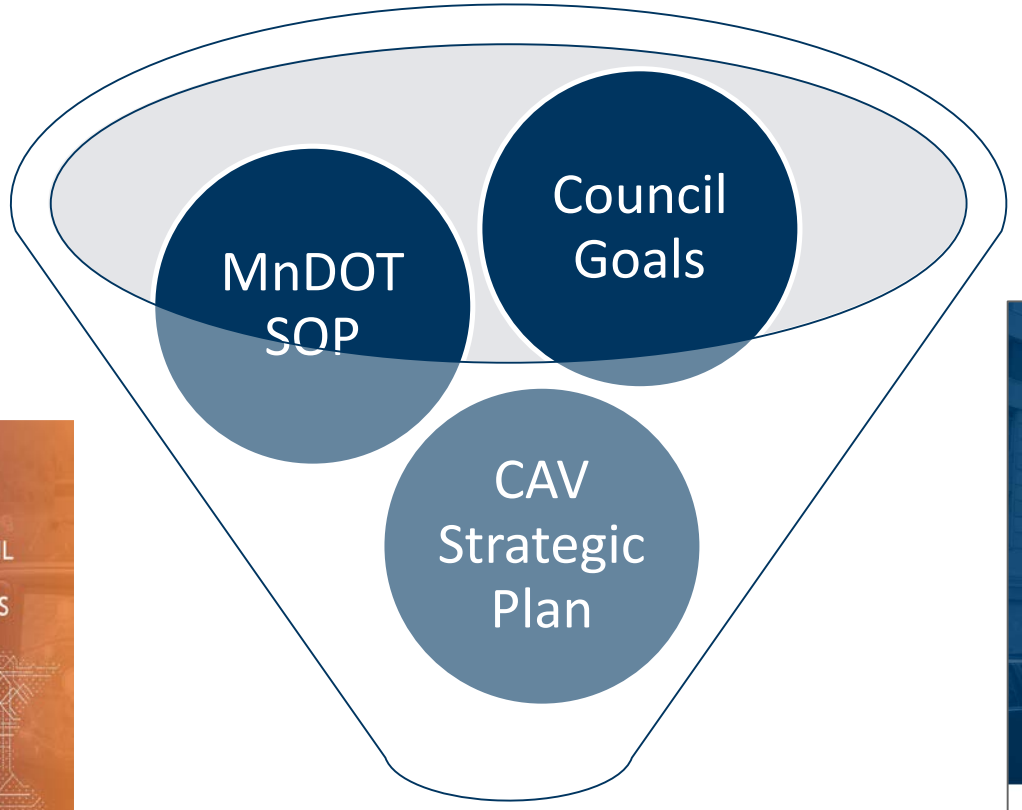
2020-2022 STRATEGIC PRIORITIES

4

CAV STRATEGIC PRIORITIES







1. COMMUNICATION, EDUCATION & OUTREACH
2. PARTNERSHIPS & COLLABORATION
3. STRATEGIC ALIGNMENT & PERFORMANCE MEASUREMENT
4. STRATEGIC STAFFING & PROCESS IMPROVEMENT

DESTINATIONCAV

DEPARTMENT OF TRANSPORTATION

MNDOT CAV STRATEGIC PLAN

65 CAV RECOMMENDATIONS IN 9 BUSINESS AREAS IN 5 YEARS

- CAPITAL INVESTMENT
- RESEARCH
- PARTNERSHIPS
- REGULATION & POLICY
- OPERATIONS & MAINTENANCE
- MULTIMODAL
- STRATEGIC STAFFING
- COMMUNICATIONS
- LONG-RANGE PLANNING

DESTINATIONCAV

DEPARTMENT OF TRANSPORTATION

HOW THE COUNCIL CAN HELP

STRATEGIC PRIORITY	STRATEGIES	HOW YOU CAN HELP
COMMUNICATIONS, EDUCATION & OUTREACH	• Communications & engagement plan • Virtual CAV demos & events • Tech Showcase & CAV Conference • Peer exchanges • MAASTO CAV eSummit • Develop local/tribal resources	• Review the plan and submit feedback • Ideas for engaging virtually • Contribute, invite partners & help plan • Know someone? Introduce us! • Attend • Refer CAV-X staff to your network
PARTNERSHIPS & COLLABORATION	• MPO and regional partnerships • Develop AV freight partners • OEM/Uber/Tesla partnerships • Fiber optic expansion • AV testing/automated delivery laws • Rural transit outreach • Monitor industry trends	• Meet to discuss partnership project ideas • Meet with AV freight partners for MN pilot • Introduce CAV-X to OEMs for MN pilot • Meet with broadband partners/Task Force • Meet with policy makers to discuss CAV • Meet across MN to discuss future needs • Share knowledge from your industries
STRATEGIC STAFFING & PROCESS IMPROVEMENT	• Build staff capacity	• Support the CAV-X program by meeting with policy makers and leaders

CAV-X TURNS 2!

RESEARCH & TESTING

DEMONSTRATIONS & ENGAGEMENT

TEAMWORK & COLLABORATION

DEPARTMENT OF TRANSPORTATION

DESTINATIONCAV

Destination CAV: Bringing the future of mobility to Minnesota

As the world is addressing global health and safety, the need for innovation and planning for the future is vital. This is the first monthly newsletter to share information about how the Minnesota Department of Transportation Connected and Automated Vehicles team (CAV-X) is working with state leaders and industry partners to help plan for the emergence of connected and automated vehicles and other emerging technology in Minnesota. This planning will ensure changes support a safe, equitable, accessible and sustainable transportation system.

NEWSLETTER & WEBINAR

DEPARTMENT OF TRANSPORTATION

CAV-X TURNS 2!

INFRASTRUCTURE INVESTMENT

PLANNING & STRATEGY

GEORGE CRONIN
★ awards for ★
Procurement Excellence
™

DESTINATIONCAV

AWARDS & RECOGNITION

NEW PARTNERS

TOP 10 TIPS

1. Divide and conquer – Don’t try to do it all
2. Statewide coordination – Build an alliance
3. Develop an innovation program
4. Technology is a means to an end
5. Create interdisciplinary teams
6. Institutionalize knowledge
7. Develop a business plan and work plan
8. Regional and national coordination
9. Use your time and money strategically
10. Outreach and engagement

BREAK

STRUCTURING AN ALLIANCE

KRISTIN WHITE & BEN LOWNDES

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STATEWIDE COORDINATION

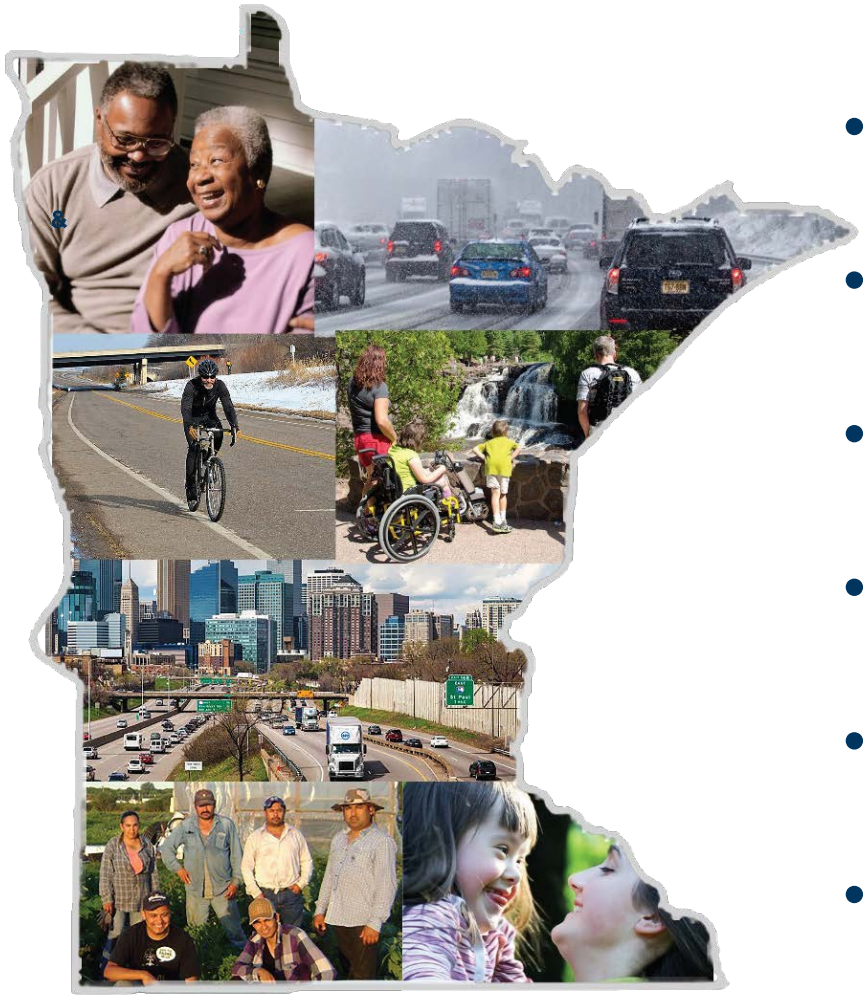
FORMER COMMITTEES

- Infrastructure
- Vehicle Registration Driver Training & Licensing
- Equity
- Insurance & Liability
- Traffic Regulations & Safety
- Economic & Workforce Development
- Accessibility
- Planning & Land Use
- Cyber Security & Data Privacy

OTHER STATEWIDE ORGANIZATIONS

- Guidestar
- Twin Cities Shared Mobility Collaborative
- University of Minnesota Center for Transportation Studies
- County Engineers
- League of Cities
- ITS Minnesota

STATEWIDE COORDINATION IS CRITICAL



- Aligns the state's various CAV organizations & work
- Economic development and job creation
- Supports regular convening and information sharing
- Implement 2018 Executive Reportrecommendations
- Collaborate to avoid redundant programming
- Coordinate and align messaging

INNOVATION ALLIANCE MODEL

- Members
- Leadership & Staffing
- Funding
- Projects

INNOVATION ALLIANCE COMMITTEES

FOCUS AREA	PRIORITIES	
SAFETY & LAW ENFORCEMENT	• Public safety • Law enforcement	• Emergency services • Crash reporting
CONNECTIVITY& DATA	• Data privacy • Data sharing	• IT & architecture • Datagovernance
INFRASTRUCTURE INVESTMENT	• Curb space mapping • Signals	• Pavement markings • Signs • Fiber optic
LABOR & WORKFORCE DEVELOPMENT	• Operators, mechanics & dealers • Workforce development	• Educational partnerships • K-12 pipeline
OUTREACH & EDUCATION	• Public demonstrations • Workshops & conferences • Open houses	• Websites • Surveys

OPPORTUNITY FOR PUBLIC COMMENT

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CLOSING

THANK YOU

GOVERNOR'S COUNCIL ON CONNECTED AND AUTOMATED VEHICLES

MARGARET ANDERSON-KELLIHER
Co-Chair

PHIL MAGNEY
Co-Chair

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