Presentation

- Pilot Overview
- Pilot Requirements
- Status
- Future Vision
- Q & A
MN Autonomous Bus Team

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Project

• Research vehicle and infrastructure requirements to safely operate an autonomous bus in cold weather climate conditions

Objective 1

• Define project pilot, perform feasibility study, perform preliminary engineering and solicit for autonomous vehicle technology vendors

Objective 2

• Finalize demonstration plan with technology vendor and conduct pilot
Minnesota & Automated Vehicles

- MN is “OPEN for Business”
- Minnesota Jurisdictional AV/CV Committee
- Minnesota Guidestar
- MnDOT Examining Statutes/Rules
  - ID Statutes/Rules Limiting AVs
  - ID Possibilities within Current Statutes/Rules
  - Perform Pilot before Promoting Legislation
# Project Goals

## Why are we doing this?

<table>
<thead>
<tr>
<th>SNOW &amp; ICE</th>
<th>OPERATIONS</th>
<th>MOBILITY</th>
<th>INFRASTRUCTURE</th>
<th>INFLUENCE</th>
<th>PARTNERSHIPS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prepare autonomous vehicle industry for snow &amp; ice conditions</td>
<td>Identify challenges and strategies for safe operation of third party autonomous vehicles on MnDOT’s transportation system</td>
<td>Prepare for improved mobility services through autonomous vehicles</td>
<td>Identify the infrastructure that is needed to ensure safe operation of autonomous vehicles</td>
<td>Increase Minnesota’s visibility and influence on advancing autonomous &amp; connected vehicles</td>
<td>Enhance partnerships between government and the autonomous vehicle industry</td>
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</tbody>
</table>
Project Activities

What are we doing?

1. Assess AV Technology
2. Develop Project Site Location Plan
3. Establish Project Requirements
6. Prepare for Test
5. Finalize Pilot Site Requirements
4. Select Technology Vendor
7. Perform Live Test
8. Evaluate Lessons Learned

Project Status – beginning to work with autonomous vehicle provider
When will this happen?

**Phase I**
- Develop Pilot Requirements (Spring 2017)

**Phase II**
- Select Vendor (Summer/Fall 2017)
  - Controlled Test: MnROAD + Super Bowl Showcase (Winter 2017 - 2018)

**Phase III (Optional)**
- Public Roadway / BRT Test(s) 2018

**Future Phase IV**
- Area Transit System Deployment(s) (TBD)

**Testing Schedule** – allows for testing during winter 2017 - 2018
### Industry / Stakeholder Interest

<table>
<thead>
<tr>
<th>Company</th>
</tr>
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<tbody>
<tr>
<td>Navya</td>
</tr>
<tr>
<td>EasyMile</td>
</tr>
<tr>
<td>Local Motors</td>
</tr>
<tr>
<td>2getthere</td>
</tr>
<tr>
<td>Autonomous Solutions Inc. (ASI)</td>
</tr>
<tr>
<td>Romaric Corporation</td>
</tr>
<tr>
<td>Velodyne Lidar</td>
</tr>
<tr>
<td>New Flyer Industries</td>
</tr>
<tr>
<td>Gillig</td>
</tr>
<tr>
<td>Hyundai-Kia America Technical Center, Inc. (HATCI)</td>
</tr>
<tr>
<td>SB Drive</td>
</tr>
<tr>
<td>Yutong</td>
</tr>
<tr>
<td>Proterra</td>
</tr>
<tr>
<td>DOTs – Colorado, Connecticut</td>
</tr>
<tr>
<td>Transit Agencies – RTD (Denver), MVTA &amp; DTA (MN)</td>
</tr>
<tr>
<td>Other – Mayo Clinic, FedEx, 3M, University of MN</td>
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</tbody>
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**April 20 Industry Forum**

Vendor / Stakeholder Outreach

[www.dot.state.mn.us/autonomous/](http://www.dot.state.mn.us/autonomous/)
Autonomous Bus Vendor Selection

• MnDOT Solicitation
  • June/July 2017

• Vendor Proposals
  • Local Motors
  • EasyMile

• Vendor NTP issued 9/15/17
Autonomous Bus Vendor

• EZ10 Shuttle
  • 91 Deployments
  • 14 Countries, 4 Continents
  • 160,000 People
  • 60,000 Miles

• Previous Pilots
  • Finland
  • Norway
  • Netherlands
  • Spain
  • Dubai
  • Singapore
  • California
  • U.S. Road Tour
# EasyMile EZ10 Shuttle

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Easy Mile</th>
</tr>
</thead>
<tbody>
<tr>
<td>Size</td>
<td>13.13’</td>
</tr>
<tr>
<td>Capacity</td>
<td>12</td>
</tr>
<tr>
<td>Speed</td>
<td>Avg. 12-15 mph, up to 25 mph</td>
</tr>
<tr>
<td>SAE Autonomy Level (0-5)</td>
<td>4</td>
</tr>
<tr>
<td>Federal Standards</td>
<td>Have received exemptions</td>
</tr>
<tr>
<td>Previous Demos</td>
<td>Fixed Routes</td>
</tr>
<tr>
<td>Super Bowl</td>
<td>Prefer Private Roads</td>
</tr>
<tr>
<td>Public Opportunity to Ride</td>
<td>Yes</td>
</tr>
<tr>
<td>Work Plan</td>
<td>Includes Safety Assessments</td>
</tr>
</tbody>
</table>
# SAE Levels of Automation

<table>
<thead>
<tr>
<th>SAE Level</th>
<th>Definition</th>
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</thead>
<tbody>
<tr>
<td>Level 0</td>
<td>Human driver does everything</td>
</tr>
<tr>
<td>Level 1</td>
<td>Automated system on vehicle can sometimes assist the human driver conduct some parts of the driving task</td>
</tr>
<tr>
<td>Level 2</td>
<td>Automated system on the vehicle can actually conduct some parts of the driving task, while the human continues to monitor the driving environment and performs the rest of the driving task</td>
</tr>
<tr>
<td>Level 3</td>
<td>Automated system can both actually conduct some parts of the driving task and monitor the driving environment in some instances, but the human driver must be ready to take back control when the automated system requests</td>
</tr>
<tr>
<td>Level 4</td>
<td>Automated system can conduct the driving task and monitor the driving environment, and the human need not take back control, but the automated system can operate only in certain environments and under certain conditions</td>
</tr>
<tr>
<td>Level 5</td>
<td>Automated system can perform all driving tasks, under all conditions that a human driver could perform them</td>
</tr>
<tr>
<td>Phase</td>
<td>Target Date</td>
</tr>
<tr>
<td>-------------------------------</td>
<td>----------------------</td>
</tr>
<tr>
<td><strong>Phase I: Pilot Testing Preparation</strong></td>
<td>Summer/Fall 2017</td>
</tr>
<tr>
<td>• Finalize Testing Requirements</td>
<td></td>
</tr>
<tr>
<td>• Provide Vehicle</td>
<td></td>
</tr>
<tr>
<td>• Prepare Site</td>
<td></td>
</tr>
<tr>
<td>• Engage in Super Bowl Showcase Discussions</td>
<td></td>
</tr>
<tr>
<td><strong>Phase II: Controlled Test</strong></td>
<td>Nov. 2017 – Feb. 2018</td>
</tr>
<tr>
<td>• Clear Weather Testing</td>
<td></td>
</tr>
<tr>
<td>• Winter Weather Testing</td>
<td></td>
</tr>
<tr>
<td>• Conduct Group Tours / Demonstrations</td>
<td></td>
</tr>
<tr>
<td><strong>Phase III: Public Road Showcase</strong></td>
<td>Jan.- Feb. 2018</td>
</tr>
<tr>
<td>• Conduct Showcases during Super Bowl Festivities</td>
<td></td>
</tr>
<tr>
<td><strong>Phase IV: Public Roadway / BRT Test(s) (Optional)</strong></td>
<td>2018</td>
</tr>
<tr>
<td>• TBD / Negotiated</td>
<td></td>
</tr>
</tbody>
</table>
Pilot Demonstration Focus

• **Vehicle**
  • Provided / operated by vendor

• **Observe Behavior**
  • Winter weather focus

• **Public Tours**
  • Public Agencies
  • Legislature
  • Special Interest Groups
  • Others

• **Super Bowl Demos**
  • Public rides
Controlled Test Site - MnROAD
Controlled Test Site

Minnesota DOT MnROAD Facility

- MnDOT owned and operated
- Low and high speed testing available (30 – 70 MPH)
- Closed loop = 2.5 miles; I-94 high speed segment = 3.0 miles
- Enabling environment, easily accessible and readily available
- Ability to create varying test conditions
- Is an AV proving ground site
Controlled Test Site

Minnesota DOT MnROAD Facility
Demonstration Plan

Testing Scenarios, Schedule & Responsibilities

- MnROAD Clear Weather
- MnROAD Winter Weather
- Observe - Various Traffic, Pavement, Visibility & Temperature Conditions
Demonstration Plan
# Demonstration Concepts

## Observations / Conditions

<table>
<thead>
<tr>
<th>Dry Weather</th>
<th>Winter / Cold Weather</th>
<th>Snow / Ice / Salt</th>
</tr>
</thead>
<tbody>
<tr>
<td>Varying Visibility</td>
<td>Various Lighting</td>
<td>Obstacles</td>
</tr>
<tr>
<td>On-coming Vehicles</td>
<td>Slow / Stopped Vehicles</td>
<td>Car Following</td>
</tr>
<tr>
<td>Intersection Turns</td>
<td>Stop / Yield Signs</td>
<td>Traffic Signals</td>
</tr>
<tr>
<td>Pedestrians</td>
<td>Bicycles</td>
<td>Right-of-Way Decisions</td>
</tr>
<tr>
<td>Parking</td>
<td>Transit Stops</td>
<td>Pick-up/Drop-off Passengers</td>
</tr>
<tr>
<td>Other</td>
<td>Other</td>
<td>Other</td>
</tr>
</tbody>
</table>
Possible Super Bowl Venue Showcase

Super Bowl LII

• Possible test showcase for Technology Vendor

• On-going discussions with
  • Minneapolis
  • Saint Paul
  • Bloomington
  • Super Bowl Planning Committees

• Option for non-public roadway showcases
  • Super Bowl event parking in private lots
National Participation

- **U.S. National Partners**
  - Colorado DOT – committed
  - Other interest expressed

- **CDOT Participation**
  - Advisor
  - Controlled testing participation
Future – Public Roadway / BRT Site(s)

Possible Local Sites

- UofM Transitway
- Duluth Canal Park
- Mayo Clinic
- MVTA Route
Future Private Sites?

Private Company Campuses

- 3M Campus
- FedEx – expressed interest
- Amazon?
Upcoming Activities

Selection Process

Issue RFP

Notice to Proceed

June - July 2017

Aug - Sept 2017

Oct - Dec 2017

Jan - Feb 2018

Finalize Pilot Requirements

Controlled Testing

Super Bowl Showcase

Key Contract Milestones
Questions & Answers

Thank You!

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