MnDOT Connected and Automated Vehicles

Jay Hietpas
CAV-X Director

Presentation Overview

• CAV-X Office
• Executive Order 18-04
• Strategic Planning
• Current Activities
• Questions
Statewide Preparation and Planning

Executive Order 18-04

- **ADVISORY COUNCIL**
  - Report to Governor and Legislature by December 1, 2018

- **TESTING AND DEPLOYMENT**
  - Requires MnDOT and DPS to establish testing and deployment programs

- **COORDINATION**
  - Establishes Interagency CAV team (I-CAV)
MnDOT CAV-X Office

CAV Director
Jay Hietpas

CAV Innovation
Kristin White

ITS Prog. Mgr.
Cory Johnson

Planning
Praveena Pidaparthi

ITS PM
Rashmi Brewer

ITS PM
Dan Rowe

ITS PM
Mike Kronzer

Engineering

Planning

Law & Policy

Statewide Coordination

Stakeholder Outreach

CAV-X Major Areas of Focus

Facilitate statewide policy and planning

Advance national policy and standards

Develop a MnDOT CAV Strategic Plan

Lead CAV research and deployment

Develop public/private partnerships
Strategic Plan

- Long Range Planning
- Capital Needs
- Research
- Partners
- Regulation
- Operations
- Strategic Staffing
- Multi-Modal
- Outreach

Other AV Related Activities

- Minnesota CAV Challenge
- Automated TMA Truck
- TH 52 Corridor
- Automated MnROAD Truck
- Testing Opportunities with Minnesota Companies
TH 55 Connected Corridor

- Signal Phasing and Timing
- Snow Plow Priority
- Data Exchange
- Pedestrian Safety

Minnesota Automated Vehicle Winter Weather Testing and Demonstrations
Project Goals

**SNOW & ICE**
- Prepare automated vehicle industry for snow & ice conditions

**OPERATIONS**
- Identify challenges and strategies for safe operation of third party automated vehicles on MnDOT’s transportation system

**MOBILITY**
- Prepare for improved mobility services through automated vehicles

**INFRASTRUCTURE**
- Identify the infrastructure that is needed to ensure safe operation of automated vehicles

**INFLUENCE**
- Increase Minnesota’s visibility and influence on advancing automated & connected vehicles

**PARTNERSHIPS**
- Enhance partnerships between government and the automated vehicle industry

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About the Easy Mile EZ10 Shuttle

<table>
<thead>
<tr>
<th>Criteria</th>
<th>EasyMile EZ10 Shuttle</th>
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</thead>
<tbody>
<tr>
<td>Capacity</td>
<td>12</td>
</tr>
<tr>
<td>Speed</td>
<td>Avg. 10-15 mph, up to 25 mph</td>
</tr>
<tr>
<td>SAE Level of Autonomy (0-5)</td>
<td>4</td>
</tr>
<tr>
<td>Obstacle Detection</td>
<td>Laser (LiDAR)</td>
</tr>
<tr>
<td>Route Setup</td>
<td>Pre-mapped/pre-programmed</td>
</tr>
<tr>
<td>Navigation</td>
<td>GPS/LiDAR</td>
</tr>
<tr>
<td>Accessibility</td>
<td>Wheelchair ramp</td>
</tr>
</tbody>
</table>
Society of Automotive Engineers (SAE)
Levels of Automation

0 1 2 3 4 5
No Automation Driver Assist Partial Automation Conditional Automation High Automation Full Automation

Full Automation

Project Phases

Phase 1
- Testing at MnROAD

Phase 2
- Operation during Super Bowl week
- Open to the public

Phase 3
- Additional tests/demonstrations
- Investigating public & private partnerships for demonstrating in an operational setting
Demonstration Concepts

**Demonstration Scenarios**

- Fair Weather Conditions
- Winter Weather Conditions

**Examples:**
- Obstacles
- Other vehicles
- Pedestrians
- Bicycles
- Transit Stops
- Stopping/Yield
- Intersections

**Intent:** Lessons Learned!
# Test Days

<table>
<thead>
<tr>
<th>Day</th>
<th>Time of Day</th>
<th>Temps / Sky Conditions</th>
<th>Pavement Conditions</th>
</tr>
</thead>
<tbody>
<tr>
<td>12/5/17</td>
<td>Night</td>
<td>23 / Partly Cloudy</td>
<td>Partial Snow Cover</td>
</tr>
<tr>
<td>12/11/17</td>
<td>Morning / Day</td>
<td>Low 30s (Feels 25) / Cloudy</td>
<td>1” Snow on Pavement</td>
</tr>
<tr>
<td>12/18/17</td>
<td>Afternoon / Night</td>
<td>36 (Feels 30) / Cloudy</td>
<td>Mostly Bare Pavement</td>
</tr>
<tr>
<td>1/2/18</td>
<td>Afternoon / Night</td>
<td>13 (Feels -3) / Light Snow, Cloudy</td>
<td>Compacted Snow / Ice Patches</td>
</tr>
<tr>
<td>1/3/18</td>
<td>Afternoon / Night</td>
<td>-3 (Feels -14) / Mostly Clear</td>
<td>Compacted Snow / Ice Patches / Loose Snow</td>
</tr>
<tr>
<td>1/4/18</td>
<td>Morning / Day</td>
<td>-4 (Feels –4) / Mostly Cloudy</td>
<td>Pavement Plowed</td>
</tr>
<tr>
<td>1/5/18</td>
<td>Morning / Day</td>
<td>-13 (Feels -23) / Sunny</td>
<td>Compacted Snow</td>
</tr>
<tr>
<td>1/8/18</td>
<td>Day</td>
<td>22 (Feels 14) / Cloud &amp; Sun</td>
<td>Snow Making</td>
</tr>
<tr>
<td>1/9/18</td>
<td>Morning / Day</td>
<td>40 (Feels 33) / Sunny</td>
<td>Road Salt</td>
</tr>
<tr>
<td>1/10/18</td>
<td>Afternoon / Night</td>
<td>37 (Feels 30) / Misty Rain &amp; Fog</td>
<td>Bare Pavement</td>
</tr>
<tr>
<td>1/11/18</td>
<td>Afternoon / Night</td>
<td>6 (Feels –10) / Wind Gusts 30</td>
<td>Bare / Snow Drifts</td>
</tr>
<tr>
<td>1/12/18</td>
<td>Day</td>
<td>-9 (Feels –24) / Sunny</td>
<td>Snow Making</td>
</tr>
</tbody>
</table>
Uncontrolled Testing Conditions

- Bare Pavement
- Light Misty Rain / Edge of Snow
- Mostly Bare Pavement
- Compacted Snow / Icy Spots

Uncontrolled Testing Conditions

- Trace - 1 Inch Fresh Snow Cover
- Loose Snow
- Low Visibility
- Blowing / Drifting Snow
Controlled Testing Conditions

- Ice for Wheel Path
- Ice Across Lane
- Ice at Start / Stop
- Ice near Intersection

Controlled Testing Conditions

- Road Salt
- Snow Making
- Made Snow Trace – 6 Inches
- Made 3 – 4 Inches of Slush
Interaction with Bicycles

Stop Distance from Bike = 6.5 Ft. (Bumper to Pedal)

Snow Making Machine

Snow: Trace to 6 Inches
Slush: Up to 3 Inches
Coverage = 500+ Feet
Nicollet Mall Demo – Ridership numbers

• Day 1 (Friday): 303
• Day 2 (Saturday): 465
• Day 3 (Sunday): 511

TOTAL riders for the 3 day demo: 1279!

Other Demonstrations

• State Capitol
• 3M Campus
• Rochester/DMC
• University of Minnesota
• Hennepin County Greenway
• MnROAD Tours
Project Video

https://www.youtube.com/watch?v=sc8X-VNHNgI

Key Project Findings

• The vehicle operated well in snow, ice and slush covered roads.
• Blowing snow = a big challenge
• Public wants more experiences to learn about AV

http://www.dot.state.mn.us/automated/bus/finalreport.pdf
Thank you!

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