Minnesota Autonomous and Connected Vehicle Perspectives

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Presentation Overview

• Autonomous (AV) and Connected (CV) Background
• AV Policy in Minnesota
• Minnesota Autonomous Bus/Shuttle Project
• Q & A
Connected Automation

**Autonomous Vehicle**
Operates in isolation from other vehicles using internal sensors

**Connected Vehicle**
Communicates with nearby vehicles and infrastructure

**Connected Automated Vehicle**
Leverages autonomous and connected vehicle capabilities
SAE Levels of Automation

0: No Automation
Zero autonomy; the driver performs all driving tasks.

1: Driver Assistance
Vehicle is controlled by the driver, but some driving assist features may be included in the vehicle design.

2: Partial Automation
Vehicle has combined automated functions, like acceleration and steering, but the driver must remain engaged with the driving task and monitor the environment at all times.

3: Conditional Automation
Driver is a necessity, but is not required to monitor the environment. The driver must be ready to take control of the vehicle at all times with notice.

4: High Automation
The vehicle is capable of performing all driving functions under certain conditions. The driver may have the option to control the vehicle.

5: Full Automation
The vehicle is capable of performing all driving functions under all conditions. The driver may have the option to control the vehicle.
Commercial Availability

LEVEL 0: Human driver does everything

LEVEL 1: Automated system on the vehicle can sometimes assist the driver

LEVEL 2: Automated system conducts some parts of the driving task, driver performs the rest

LEVEL 3: Automated system conducts most of the driving task, but driver must be ready to take back control

LEVEL 4: Full vehicle autonomy in certain environments

LEVEL 5: Full vehicle autonomy for the entire trip duration

*Adapted from a forecast by University of Minnesota Researchers
Thinking beyond the car
Mobility for People with Disabilities

• Huge potential, but **not** a given

• Many user-interface and vehicle design questions
Why is this important to Government?

- Safety
- Changes in operations
- Infrastructure Changes
- Regulation
- Public Acceptance
- Testing
- Work Force
What are the Challenges?

- Work Zones
- Salt
- Snow / Ice
Statewide - Jurisdictional Committee
Strategic Planning

• What Should We Focus On?

• Long Range Plan

• Current Investments

• Work Force

• Operations

• Connected Vehicles
Trying to Work Together

**Minnesota Guidestar & ITS**
- Stakeholder Collaboration
- Statewide Strategic Direction Advice

**MnDOT TSMO**
- Set MnDOT Policy and Strategic Direction
- Identify and recommend AV / CV projects for implementation

**Statewide Juris Committee**
- Composed of State Agencies
- Set statewide direction for AV/CV regulations
- Forum for sharing current trends and initiatives

**Private Industry**
- Develop technologies
- Assist agencies with testing and implementation

**Other Government & Academia**
- Research and Implement Projects
- Develop internal strategies

**Special Interests**
- Influence Policy and Regulation
- Implementation opportunities
Lessons Learned

- Collaboration among agencies
- Getting stakeholders to engage early
- Allow opportunity to see and touch
- How to prioritize development of these technologies among other competing needs
MN AV Test - Why are we doing this?

- AV is Coming
- Climate
- Limited testing in winter conditions
- Prepare Minnesota
# Project Goals

<table>
<thead>
<tr>
<th>Snow &amp; Ice</th>
<th>Operations</th>
<th>Mobility</th>
<th>Infrastructure</th>
<th>Influence</th>
<th>Partnerships</th>
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<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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1. Identify if autonomous shuttles are operating in cold weather climates

2. Determine if autonomous shuttle vendors are willing to operate in cold weather climates

3. Procure vendor to test

4. Test / Demonstrations
Operation of AV in Transit History
# Industry / Stakeholder Interest

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

Vendor / Stakeholder Outreach

www.dot.state.mn.us/autonomous/
• Level of Automation (2-5)
• Ability to Operate on a Public Road
• Size and Speed
• History of Testing
• Work Plan
• Super Bowl Showcase
Lessons Learned

• Size of Bus
• Industry Concerns (labor unions)
• Willing to operate on public roadways
• Technology limitations
• Ready to test in cold weather
Vendors Responding to RFP

Local Motors

EasyMile
Phase I – MnROAD Testing
Connected Vehicle Projects

Vehicle to Infrastructure
Transit Priority
Fuel Efficiency
Thank you again!

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