Preparing our Roadways for Connected and Automated Vehicles
This presentation will address how CAVs will require planners and engineers to consider emerging trends in developing short- and long-range transportation plans.
Emerging transport and related technology has the potential to significantly alter the performance of our transport networks over the next 30 years.

Overview

- Why are CAVs Needed
- Travel Behavior Impacts
- Freight Impacts
- Transit Integration
- CAV Barriers
Why?

- Safety:
  - Drunk driving
  - Speeding
  - Driver distraction

- Congestion Management:
  - Tighter headways
  - Platoons
  - Speed harmonization
  - Route choices

- Parking Savings:
  - Fringe parking
  - Automated pick ups, drop offs

- Environmental:
  - Fuel consumption savings
  - Air emission savings
Travel Behavior

- **Mobility** for young, old, disabled
- May result in **increased VMT**
- May combine with **road pricing**
- On demand **shared AV rides**
- May encourage **land use changes**

Automated Vehicles enables users to legitimately and safely multi-task (e.g., texting, working).
Pros:
- No truck drivers, just warehouse employees handling containers at either end
- Labor cost and fuel savings, travel time savings, less incidents

Cons:
- Possible resistance from labor unions and competing railroads
- Tight vehicle spacing on roads (road-trains) could cause problems for other motorists
- Designated AFV routes will need to have reinforced road surfaces to increase service life

Opportunities:
- DOTs state-wide ITS can be used to route commercial freight around congested areas
- DOTs could facilitate platooning services for AFVs
- A wide variety of services can be offered to freight operators
Transit

- Automated vehicles are expected to work best in **line-haul segments**
- Focus on **first mile/last mile** service
- May compete with transit due to increased **user productivity**
- AV buses may **reduce insurance costs** as they are safer
Barriers

Vehicle Costs:
- $70-$100K per vehicle to add sensors, communications, guidance technology, software
- With mass production, prices may fall to $25-$50K, then to $10K in ten years
- Potential savings in fuel, insurance and parking costs may offset some initial costs
- Need to reduce cost to less than $3K to make it marketable to the average consumer

AV Licensing:
- California & Nevada legislation allows AV licensing
- Florida & Washington, DC allows AV testing
- Legislation impending in HI, MA, MI, MN, NJ, NY, SC, WA, WI
- States are looking for DMVs to set the requirements for licensing and testing
Barriers

**Liability:**
- Who is at fault in a crash
- What degree do AVs protect occupants vs other crash victims
- Should owners be allowed to adjust settings
- Should states set different legal guidelines by AV Levels

**Security:**
- V2V and V2I security protocols were built into the initial development of CVs
- US’s demonstrated success in mission critical systems (e.g., power grids, air traffic control)
- Computer hackers, disgruntled employees, and terrorists may cause collisions

**Privacy:**
- Who should own or control the vehicle data? (OEMs, Technology Suppliers)
- What types of data will be stored? (routes, destinations, TOD)
- With whom will these data sets be shared? (TMCs)
- In what ways will this data be made available? (Traffic Signals)
- How will the data be used? (Transportation Planning, Law Enforcement, Advertising)
Intelligent network management encompasses a wide variety of tools designed to improve system efficiency.

- Real-time Understanding of Network
- Dynamically Manage Travel Demand
- Big Data Management
- Asset Maintenance & Renewals
- Planning for New Investments
Intelligent Network Management

- TSM&O (ATM, ICM, Managed Lanes)
- TMC Proactive Operations
- Active Arterial Management
- Ramp Metering
- Traveler Information Systems

Many transportation agencies are already advancing components of their Intelligent Networks applying a TSM&O approach.
Emerging Technology Trends

- Multimodal Sensor Networks
- Predictive Analytics
- Decision Support Systems
- Big Data Partnerships
- CAV Infrastructure

Intelligent network management encompasses a wide variety of tools designed to improve system efficiency.
Emerging Vehicle Technology

- **Forward Vision System**
  - Lane tracking
  - Object detection
  - Far IR capability

- **Rear Vision System**
  - Object detection
  - Far IR capability

- **Enhanced Digital Map System**

- **Short-Range Blind-Spot Sensors**

- **Short-Range Sensors**

- **Long-Range Sensors**

- **Long-Range Scanning Sensor**
Connected Vehicles

- Cooperative Adaptive Cruise Control
- Communicate with Roadside Sensors
- Communicate with TMCs
- Wireless Access to Internet
- Connect to Personal Devices

Connected vehicles can significantly improve the efficiency of roadway networks by enabling shorter following distances, mitigating start-stop shockwaves and dynamic management of traffic flows.
## Automated Vehicles

<table>
<thead>
<tr>
<th>Level</th>
<th>Description</th>
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</thead>
<tbody>
<tr>
<td>0</td>
<td>No Automation - The human driver is in complete control of all functions of the car.</td>
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<tr>
<td>1</td>
<td>Function-Specific Automation - <strong>One function</strong> is automated. (adaptive cruise control, collision avoidance, lane departure)</td>
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<td>2</td>
<td>Combined-Function Automation - <strong>More than one function</strong> is automated at the same time (e.g., steering and acceleration), but the driver must remain constantly attentive.</td>
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<tr>
<td>3</td>
<td>Limited Self-Driving Automation - The driving functions are sufficiently automated that the driver can safely engage in other activities (e.g., driver expected to be available for occasional control)</td>
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<tr>
<td>4</td>
<td>Full Self-Driving Automation - The <strong>car can drive itself without a human driver</strong> (e.g., vehicle provides all safety functions, driver provides destination)</td>
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</table>
## Roadway Capacity Impacts

<table>
<thead>
<tr>
<th>Percentage of Cooperative Adaptive Cruise Control Vehicles</th>
<th>10%</th>
<th>20%</th>
<th>30%</th>
<th>40%</th>
<th>50%</th>
<th>60%</th>
<th>70%</th>
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<td>30%</td>
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Source: Dr. Shadover, 2012
Potential strategies may be considered to accelerate CAV uptake, if desired.

- CAV Trials to Test Impacts
- CAV Infrastructure Upgrades (DSRC)
- Digitally Mapped Network
- Financial Incentives (Tax Breaks)
- CAVs enabled to use Managed Lanes
- “Here I Am” Units
- CAVs on Lower Transit-Use Routes
Shared mobility business models, coupled with the ‘internet of things’, have the potential to change personal travel towards a more multi-modal future where mobility is thought of as a service.
Emerging Technology Trends

- Reduced Car Ownership
- Improved Accessibility
- Reduced Need for Parking
- Reduced VMT and Emissions
- Complements Transit Service

Shared mobility is often facilitated by technology and data to connect people and places whatever the mode used.
Accelerating Shared Mobility

- Transit Integration
- Land-Use Integration
- Parking Availability Policies
- Changes in Travel Behavior
- Private Sector Innovations

Shared mobility as a business model has the potential to significantly improve connectivity and transport outcomes.
New Zealand – Preparing for CAVs

The findings included in this presentation was largely based on a study conducted by AECOM for the New Zealand Transportation Agency.

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Moderate</th>
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<th>Fast</th>
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<td>Intelligent Network Mgmt</td>
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<tr>
<td>Shared Mobility</td>
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</table>
Combined Effects on Planning

Moderate Scenario

- Accessibility
- Congestion
- PT mode share
- Value for money

Fast Scenario

- Accessibility
- Congestion
- PT mode share
- Value for money

ATAP Objective
Internet of Things

- Internet Protocol
- 75M Servers
- 1.2B Cars
- Unused Capacity
- Share Transport Resources
- Connected & Automated Vehicles
- Designated Pickup/Dropoff
- Packets of People & Cargo
- Decentralize Car Ownership

Key points:
- Internet
- Protocol
- Connected & Automated Vehicles
- Shares Transport Resources
- Designated Pickup/Dropoff
- Packets of People & Cargo
- Decentralize Car Ownership
- 75M Servers
- 1.2B Cars
- Unused Capacity
Summary

- Travel Behavior Changes will Influence Technology Decisions
- Technology Advancements Can Dramatically Improve Performance
- Induced Demand May Offset Efficiencies Gained By Technology
- Technology Changes Could Alter the Course of Public Transit
- Flexible Planning Approach Needs to Accommodate Technology
- Research is Needed for CAV and Shared Mobility Infrastructure
- Research is Needed to Accelerate the Uptake of New Technologies