Initial Assessment of Connected Vehicles and Autonomous Vehicles Technologies on System-wide Performance Measures

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Agenda

• Contra Costa Transportation Authority (CCTA) Overview and Goals
• Study Objective and Approach
• Sensitivity Analysis and Results
• Conclusion
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CCTA Overview and Goals

• Contra Costa Transportation Authority
  • Manages transportation sales tax program
  • Countywide transportation planning

“CCTA is responsible for maintaining and improving County’s transportation system by planning, funding, and delivering critical transportation infrastructure projects and programs that connect our communities, foster a strong economy, increase sustainability, enhance safety and efficient mobility”.
CCTA Transportation Leadership

- GoMentum Station
- City of Concord, Automobile manufacturers, Communications companies, Technology companies, Researchers and Public agencies
- 5,000 acres
- Facilitating R&D, testing, validation and deployment of CV/AV technologies
- Public-Private Partnership model
TJKM
Transportation Consultants

- Multi-disciplinary firm with Nearly 45 Years Track Record
- Plan, Design, and Implement Transportation Projects
- Delivering “Projects” that Support Vibrant and Sustainable Communities
- Comprehensive Planning Approach and Innovative Designs Backed by Technical and Analytical Strength
Agenda

• Contra Costa Transportation Authority (CCTA) Overview and Goals
• **Study Objective and Approach**
• Sensitivity Analysis and Results
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Study Objective

- Evaluate the impacts of CV/AV technologies on system wide performance measures
Assessment of CV/AV Technologies

- CCTA is interested in understanding the impacts of CV/AV on transportation planning and policy
- Forecasting CV/AV technologies complex
- Early stages
- Initial assessment
- Traditional four-step travel demand forecasting
CCTA Travel Demand Model (1 of 2)

- CCTA Travel Demand Model provides traffic forecast through Year 2040 and covers the 9 San Francisco Bay Area counties.

- Travel Demand Model is used for:
  - Analyzing the effects of new developments
  - General plan update
  - Countywide Comprehensive Transportation Plan Update
  - Congestion Management Program
CCTA Travel Demand Model (2 of 2)

- TransCAD platform
- 3,200 TAZ’s.
- Base Year 2010
- Future Years
  - 2020, 2030 and 2040
- Time Periods
  - AM Peak
  - PM Peak
  - Off-Peak
- Multi-modal including Transit
- Run time 8 hrs
### Automation Levels - Definition

<table>
<thead>
<tr>
<th>Level</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>No Automation</td>
</tr>
<tr>
<td>1</td>
<td>Driver Assistance</td>
</tr>
<tr>
<td>2</td>
<td>Partial Automation</td>
</tr>
<tr>
<td>3</td>
<td>Conditional Automation</td>
</tr>
<tr>
<td>4</td>
<td>High Automation</td>
</tr>
<tr>
<td>5</td>
<td>Full Automation</td>
</tr>
</tbody>
</table>

- **No Automation**: Zero autonomy; the driver performs all driving tasks.
- **Driver Assistance**: Vehicle is controlled by the driver, but some driving assist features may be included in the vehicle design.
- **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.
- **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.
- **High Automation**: The vehicle is capable of performing all driving functions under certain conditions. The driver may have the option to control the vehicle.
- **Full Automation**: The vehicle is capable of performing all driving functions under all conditions. The driver may have the option to control the vehicle.

Study Approach and Assumptions

- Establish a **2040 Baseline** with zero CV/AV scenario using the existing 2040 CTP model data set
- **4 sensitivity analyses** of system performance measures of effectiveness
- Limited Level 4 vehicle autonomy
- System performance measures of effectiveness:
  - Vehicle hours travelled (VHT)
  - Vehicle-miles-travelled (VMT) by speed bin
- Improved **platooning** results in increased freeway throughput from 2,000 to 3,300 VPHPL
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• Scenarios Tested:

• Scenario 1 – Level 4 Autonomy with 30% capacity gain and 5% speed gain

• Scenario 2 - Level 4 Autonomy with 70% capacity gain and 5% speed gain

• Scenario 3 – Level 4 Autonomy with 30% capacity gain and 10% speed gain

• Scenario 4 - Level 4 Autonomy with 70% capacity gain and 10% speed gain
## Sensitivity Analysis Results

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Capacity Gain</th>
<th>Speed Gain</th>
<th>VMT</th>
<th>VHT</th>
</tr>
</thead>
<tbody>
<tr>
<td>No CV/AV</td>
<td></td>
<td></td>
<td>50,530</td>
<td>1,825</td>
</tr>
<tr>
<td>Scenario 1</td>
<td>+30%</td>
<td>+5%</td>
<td>50,170</td>
<td>1,315</td>
</tr>
<tr>
<td>Scenario 2</td>
<td>+70%</td>
<td>+5%</td>
<td>50,115</td>
<td>1,175</td>
</tr>
<tr>
<td>Scenario 3</td>
<td>+30%</td>
<td>+10%</td>
<td>50,075</td>
<td>1,285</td>
</tr>
<tr>
<td>Scenario 4</td>
<td>+70%</td>
<td>+10%</td>
<td>49,965</td>
<td>1,150</td>
</tr>
</tbody>
</table>

VMT and VHT in Thousands (1,000)
CV/AV Sensitivity Analysis Results

![CV/AV Sensitivity Analysis Graph]

The graph above illustrates the CV/AV Sensitivity Analysis results for different scenarios. The x-axis represents the scenarios from 'No Build' to 'Scenario 4', while the y-axis shows the percentage of No-Build VMT. Each scenario's data is represented by a blue column, indicating the % of No-Build VMT, and a red line shows the % of No-Build VHT. The graph shows a decrease in % of No-Build VMT as we move from 'No Build' to 'Scenario 4', with a slight increase in % of No-Build VHT for some scenarios.
### Changes in VMT by Speed

<table>
<thead>
<tr>
<th>Speed Range</th>
<th>No Build</th>
<th>Scenario 1</th>
<th>Scenario 2</th>
<th>Scenario 3</th>
<th>Scenario 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-10 mph</td>
<td>1,975</td>
<td>355</td>
<td>10</td>
<td>355</td>
<td>5</td>
</tr>
<tr>
<td>10-20 mph</td>
<td>5,045</td>
<td>3,415</td>
<td>2,935</td>
<td>3,335</td>
<td>2,930</td>
</tr>
<tr>
<td>20-30 mph</td>
<td>10,220</td>
<td>2,570</td>
<td>1,685</td>
<td>2,485</td>
<td>1,640</td>
</tr>
<tr>
<td>30-40 mph</td>
<td>12,085</td>
<td>11,760</td>
<td>9,315</td>
<td>11,745</td>
<td>9,290</td>
</tr>
<tr>
<td>40-50 mph</td>
<td>8,570</td>
<td>9,045</td>
<td>7,260</td>
<td>9,095</td>
<td>7,540</td>
</tr>
<tr>
<td>50-60 mph</td>
<td>8,210</td>
<td>13,155</td>
<td>15,680</td>
<td>12,545</td>
<td>14,315</td>
</tr>
<tr>
<td>&gt;60 mph</td>
<td>4,425</td>
<td>9,870</td>
<td>13,230</td>
<td>10,515</td>
<td>14,240</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>50,530</strong></td>
<td><strong>50,170</strong></td>
<td><strong>50,115</strong></td>
<td><strong>50,075</strong></td>
<td><strong>49,965</strong></td>
</tr>
</tbody>
</table>

VMT in Thousands (1,000)
% VMT by Speed Bin

- 0-10 mph
- 10-20 mph
- 20-30 mph
- 30-40 mph
- 40-50 mph
- 50-60 mph
- >60 mph

Scenarios:
1. No Build
2. Scenario 1
3. Scenario 2
4. Scenario 3
5. Scenario 4
Limitations

- Auto ownership - ridesharing
- New trips by people who don’t drive
- Last mile connectivity – mode shift
- Operational efficiencies
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- CCTA Travel Demand model can quantify the effect of CV/AV on VMT and VHT, with limitations.

- VMT were projected to reduce (by approximately 1%) as the impacts of CV/AV technologies on mode shift were ignored.

- A shift of VMT occurs from low functional classification to higher functional classification roads.

- VHT were projected to reduce (by approximately 37%) due to the capacity and speed gains.

- More detailed analyses will need to be conducted with advanced modeling tools.
Thank You