Data Inputs and Impacts to Connected and Automated Vehicle Modeling: Takeaways from ISTTT 22

Alex Skabardonis
University of California, Berkeley

97th TRB Annual Meeting
January 7, 2018
Washington, DC
Background

**ISTTT22 FHWA WORKSHOP**
GETTING THERE FROM HERE:
Traffic Modeling, Data Streams, and Prediction for Connected/Automated Vehicle Systems Planning and Operations

**ISTTT22 PAPER SESSION**
Connected/Automated Vehicles

**AVS 2017 SYMPOSIUM BREAKOUT SESSIONS**
- CAV Scenarios for High Speed, Controlled Access Facilities
- Capacity & Delay Implications of CAV at Signalized Intersections
- Enhancing the Validity of Traffic Flow Models with Emerging Data
Workshop Objectives

- Identify gaps in current methods and tools with regard to incorporating CAV’s in simulation and network modeling tools
- Discuss ongoing developments in models and applications related to the impact of CAV’s
- Identify challenges and opportunities for fundamental and applied research
The Promise..
Modeling Needs

Source: Srinivas Peeta
Existing models need to be updated/modified/discarded to account for changes due to CAVs
  Simplified assumptions on car-following, lane changing macroscopic traffic flow relationships/models

New models to leverage new technological capabilities, and capture emergent interactions
  Operational and communication protocols
  Modeling platoon streams for CAVs
    Platoon stability
    Impacts of latency

Modeling challenges in the transition period
  Dedicated lanes for CAVS
  Interactions with manually driven vehicles
  Car-following model for mixed traffic
Models: Challenges and Opportunities (2)

- Modeling of CAVs and technology integration (V2X)
  Traffic signal control
  ATM strategies on freeways
  Highway design for mixed and purely autonomous vehicles

- Modeling Incidents/Re-routing
  Diversion strategies under cooperation and real-time information available to CAVs

- Model Calibration
  Data sources?
  Framework?
CAVs Freeways Models: Capacity of AHS Lane

Capacity \( C = \frac{v \cdot n}{[ns + a(n - 1) + d]} \text{ veh/lane/hour} \)
Assume \( v = 72 \text{ k/h, } s = 5\text{m.} \) Then

<table>
<thead>
<tr>
<th>n</th>
<th>a</th>
<th>d</th>
<th>C</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>-</td>
<td>30</td>
<td>2,100</td>
</tr>
<tr>
<td>5</td>
<td>2</td>
<td>60</td>
<td>3,840</td>
</tr>
<tr>
<td>15</td>
<td>2</td>
<td>60</td>
<td>6,600</td>
</tr>
<tr>
<td>20</td>
<td>1</td>
<td>60</td>
<td>8,000</td>
</tr>
</tbody>
</table>

Notes
- n=20 yields nearly 4 times today’s capacity
- capacity proportional to speed
Model: CACC Lane Capacity

Cooperative Adaptive Crouse Control (CACC)
Data Opportunities-Challenges

CAVs can be used as mobile sensors
CAVs provide trajectory data
Data available from mobility service providers

- Operational Characteristics
  - Lost time reduction
  - Increased saturation flow rate

- Control Strategies
  - Multimodal adaptive control
  - Dynamic lane allocation
  - Eco Driving
  - Signal-Free Intersections
Challenges

- Current TMC systems are not equipped to handle CAV data
  *Minimizing data transmission/processing costs while maintaining accuracy and timeliness requirements*
- No standards/procedures exist for collecting, processing integrating CAV data into existing operations
- CAV Operational Characteristics not yet determined
- Effect of advance information on CAVs is unknown until tested
- Impacts on intersection capacity and performance depend on CAVs penetration rate (*will change over time*)
Impact of Penetration Rates: NGSIM Data

![Graphs showing impact of penetration rates on space and time data with different penetration rates: p = 100%, p = 50%, p = 25%, p = 10%.]
CAVs Saturation Headway
CV & Traffic Signals: Eco-Driving

Messages
“Here I am”
Signal Phase & Timing (SPaT)

Application: Dynamic Speed Advisory (source: UC & BMW)

14% Reduction in Fuel Use
Delay Savings
CAVs & Traffic Signals: Dynamic Lane Grouping
Public Agencies: Operational/Planning Analyses

What will be the capacity of freeway lane with CAVs?
What are the impacts on operational performance (reliability)
What link capacity to use in 2030 transportation plans?
Do I need traffic lights?

- Highway Capacity Manual Procedures
  Use of “adjustment factors”
  Example: Critical Intersection control strategy improves intersection capacity by 7%
  Based on field data

- Source of Factors
  Field data (not yet available)
  Simulation (assumptions)
Implementation Challenges

Background: Initial Deployment Plans

Planned US VII Deployment’06

[Map of the United States showing network connections and markers for planned deployments]

Legend:
- Interstate
- Strategic HWY Network
- Strategic HWY Connector
- Other NHS
- Intermodal Connector
- NHS Intersections
- Additional Interchanges

17