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

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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

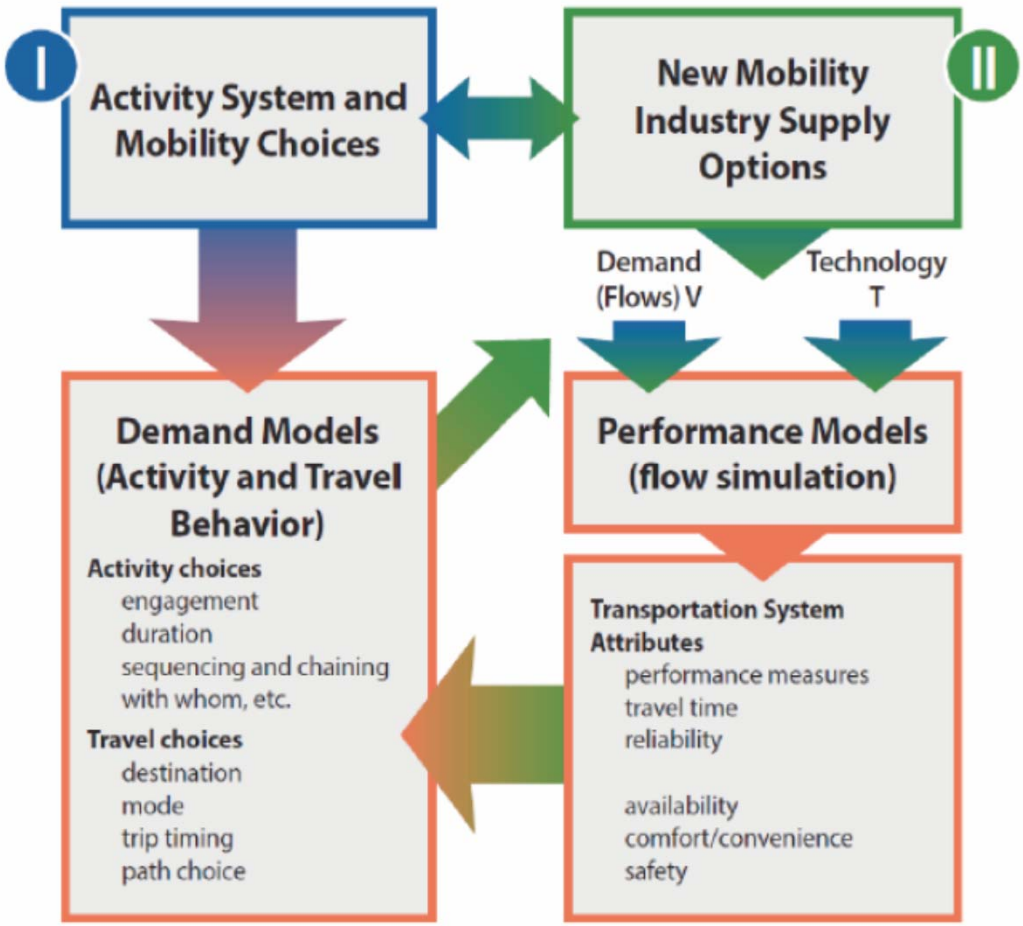
Connected/Automated Vehicles

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**

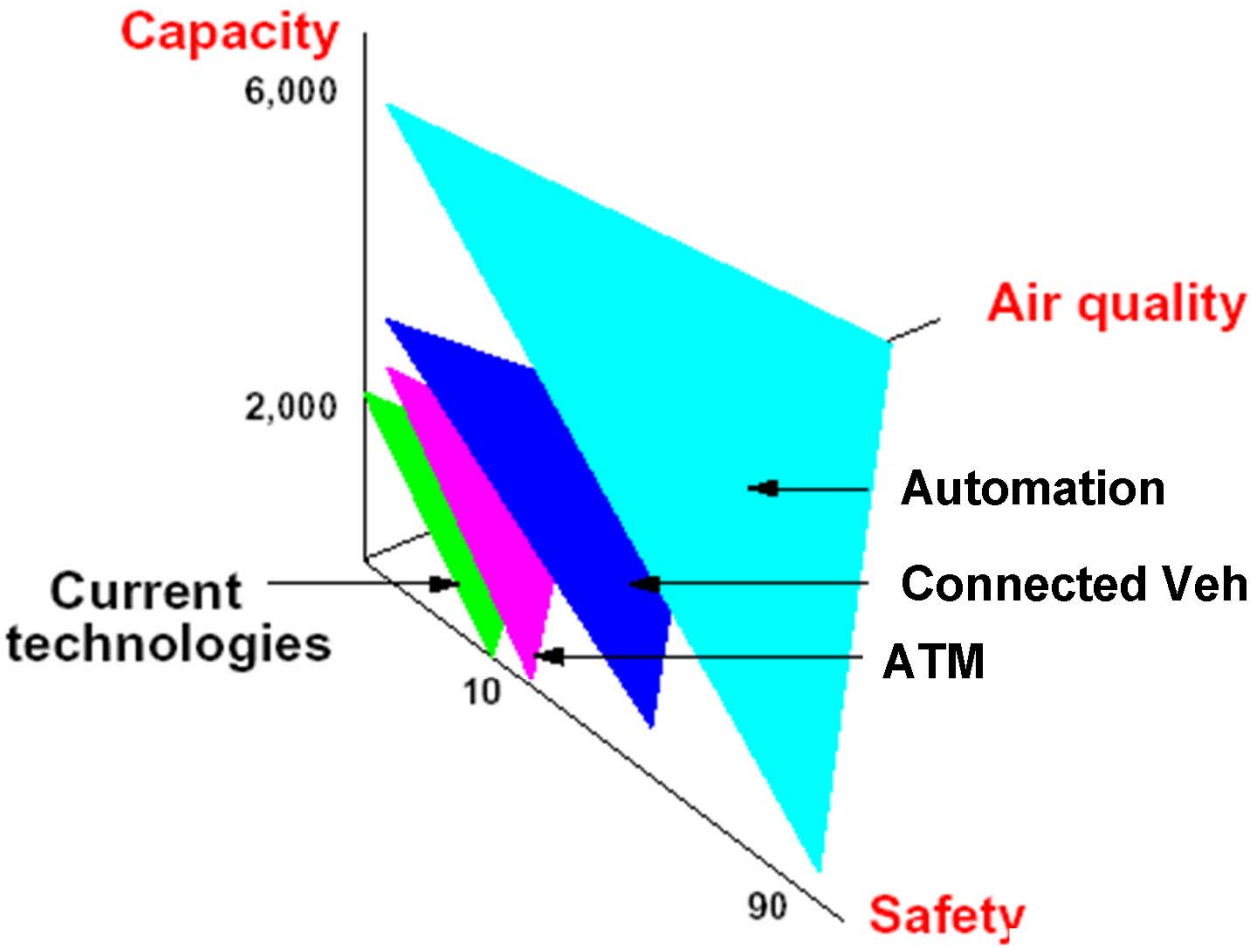
Workshop Objectives

- 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

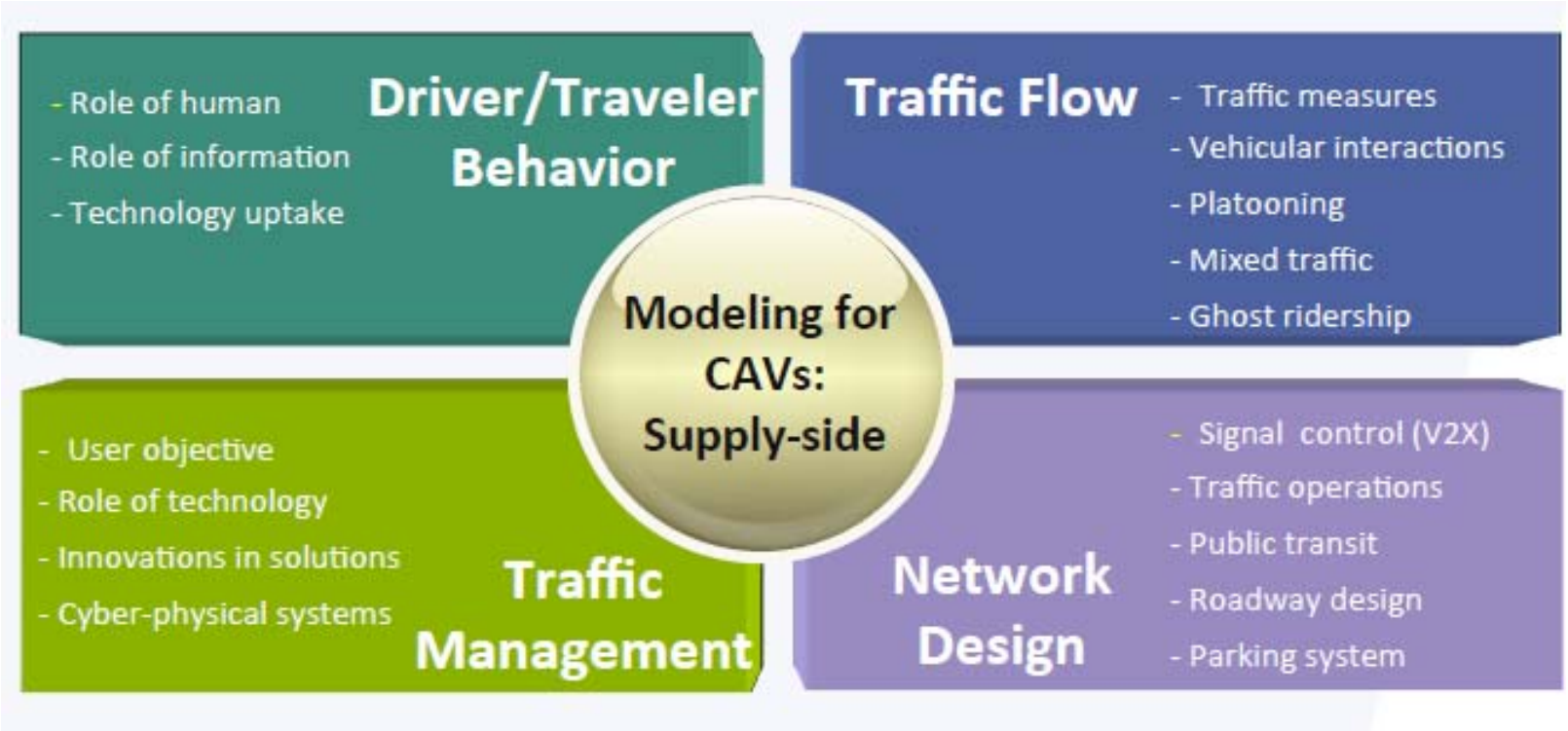


Methodological framework for network- and system-level assessment of CAV impacts. (Source: FHWA).

The Promise..


Capacity
6,000
2,000
Air quality
Automation
Connected Veh
ATM
Current technologies
10
90
Safety

Modeling Needs



Source: Srinivas Peeta

Models: Challenges and Opportunities (1)

- **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

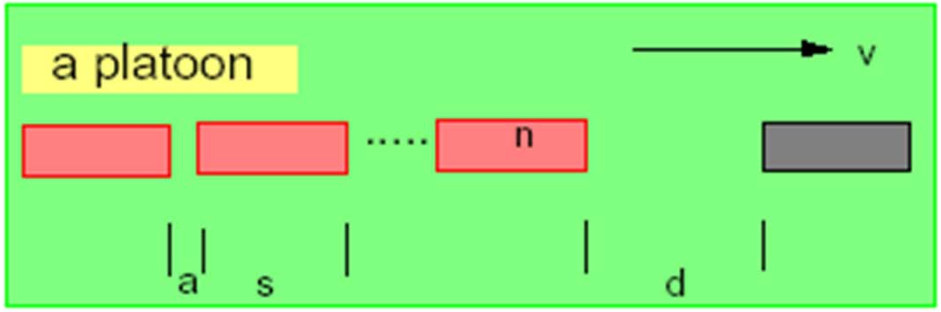
Models: Challenges and Opportunities (2)

- **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 = v . n / [ns + a(n - 1) + d] veh / lane / hour

Assume v = 72 k/h, s = 5m. Then

n	a	d	C
1	-	30	2,100
5	2	60	3,840
15	2	60	6,600
20	1	60	8,000

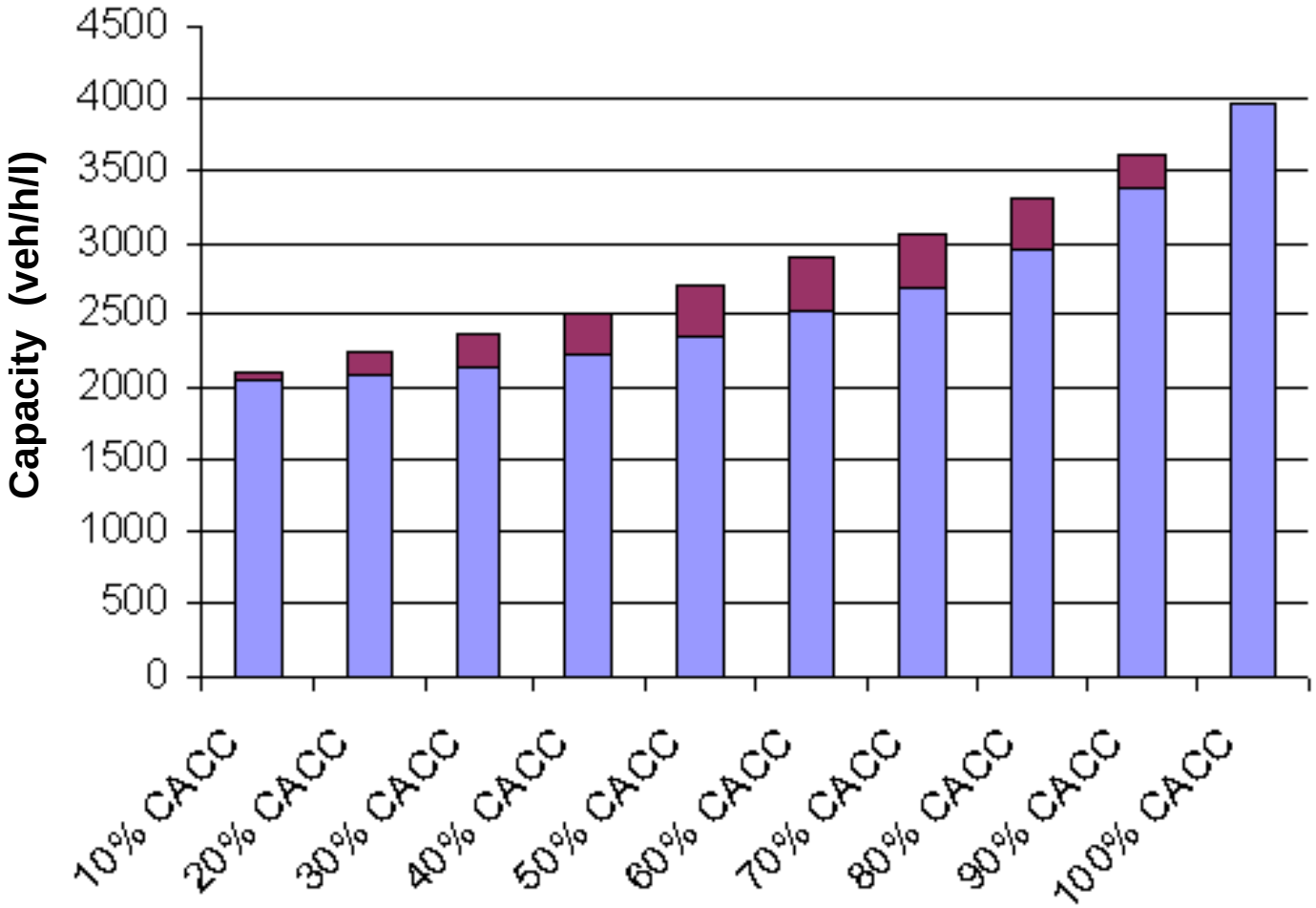
Notes

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

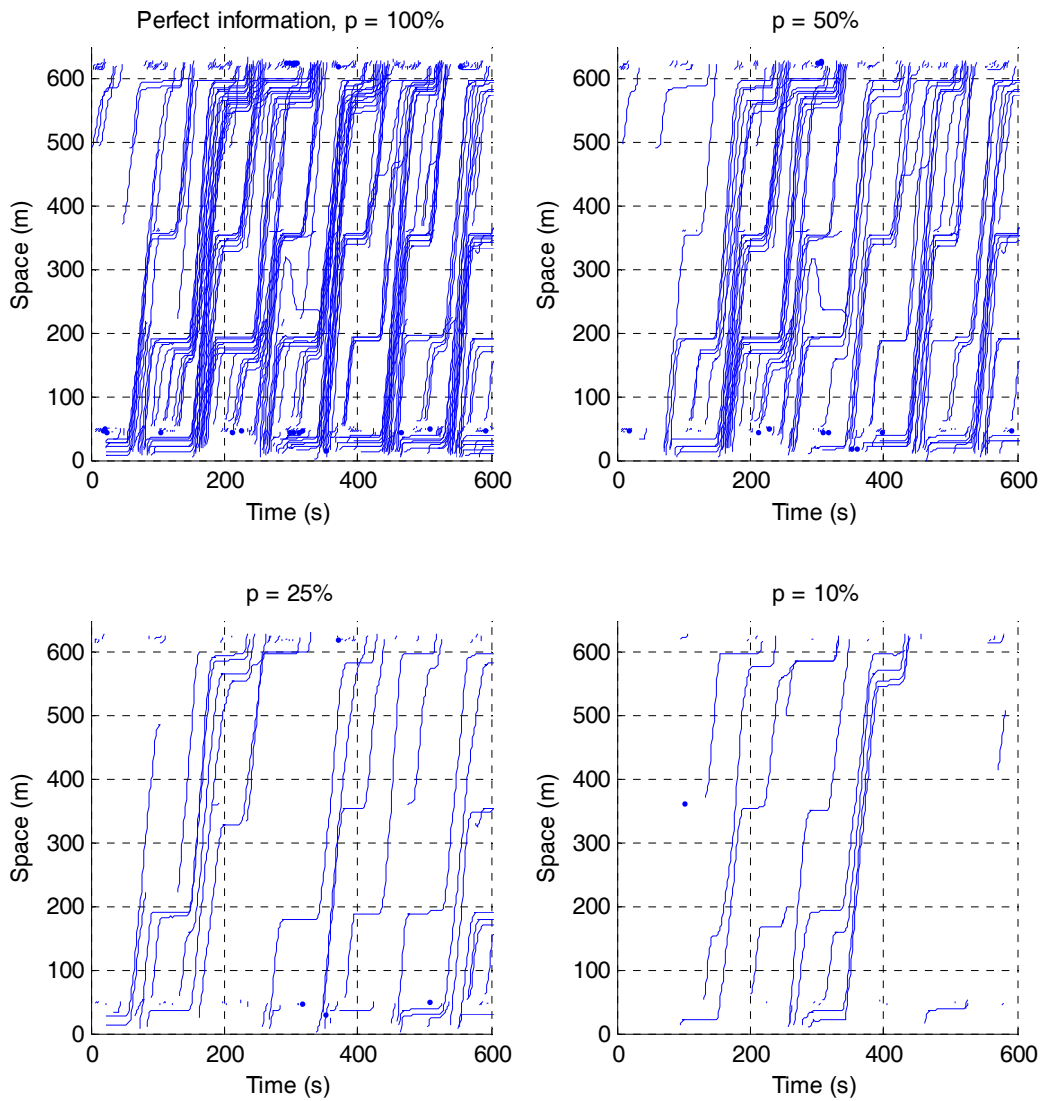
- **No standards/procedures exist for collecting, processing integrating CAV data into existing operations**

- **CAV Operational Characteristics not yet determined**

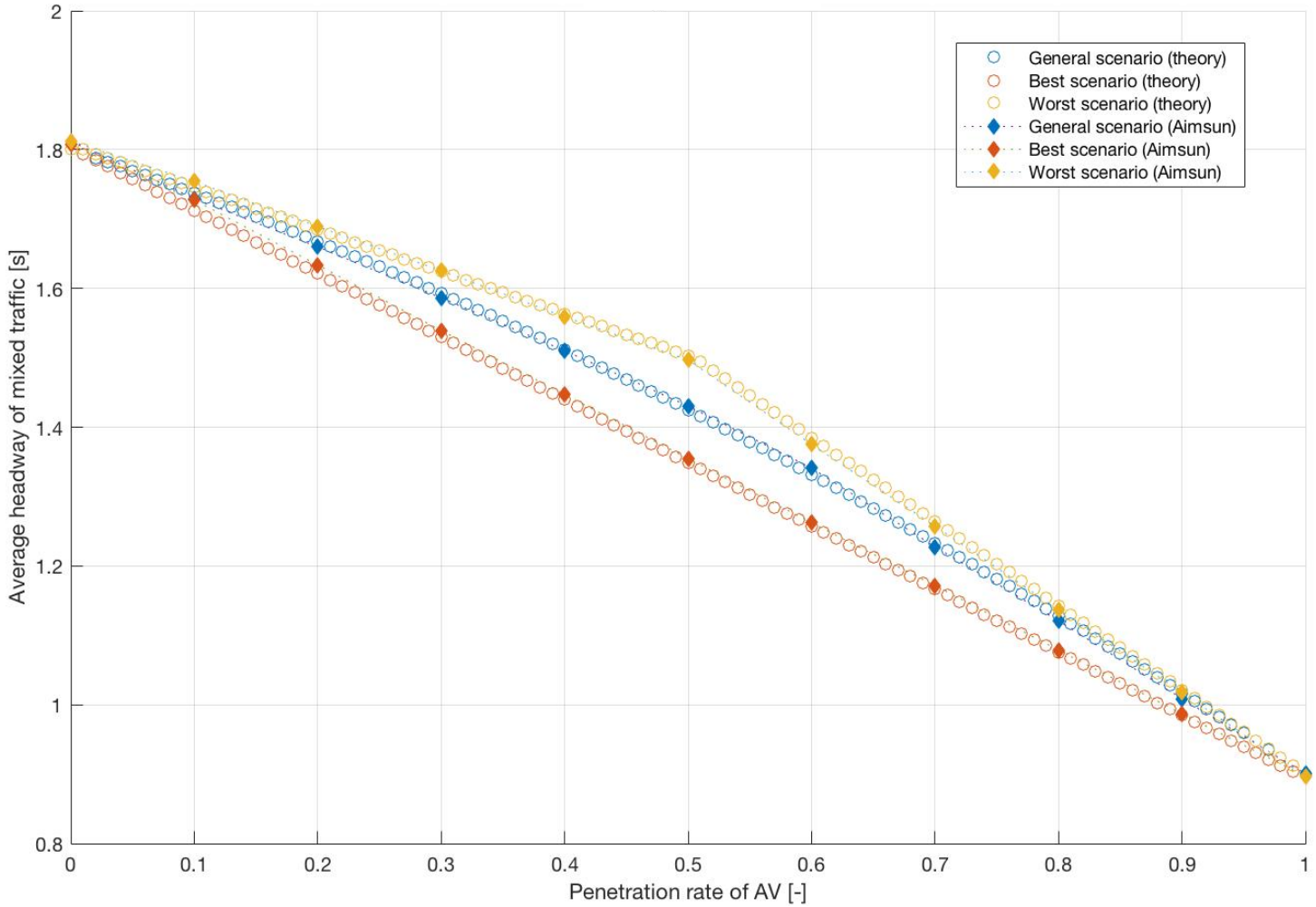
- **Effect of advance information on CAVs is unknown until tested**

- **Impacts on intersection capacity and performance depend on CAVs penetration rate (*will change over time*)**

Impact of Penetration Rates: NGSIM Data



CAVs Saturation Headway



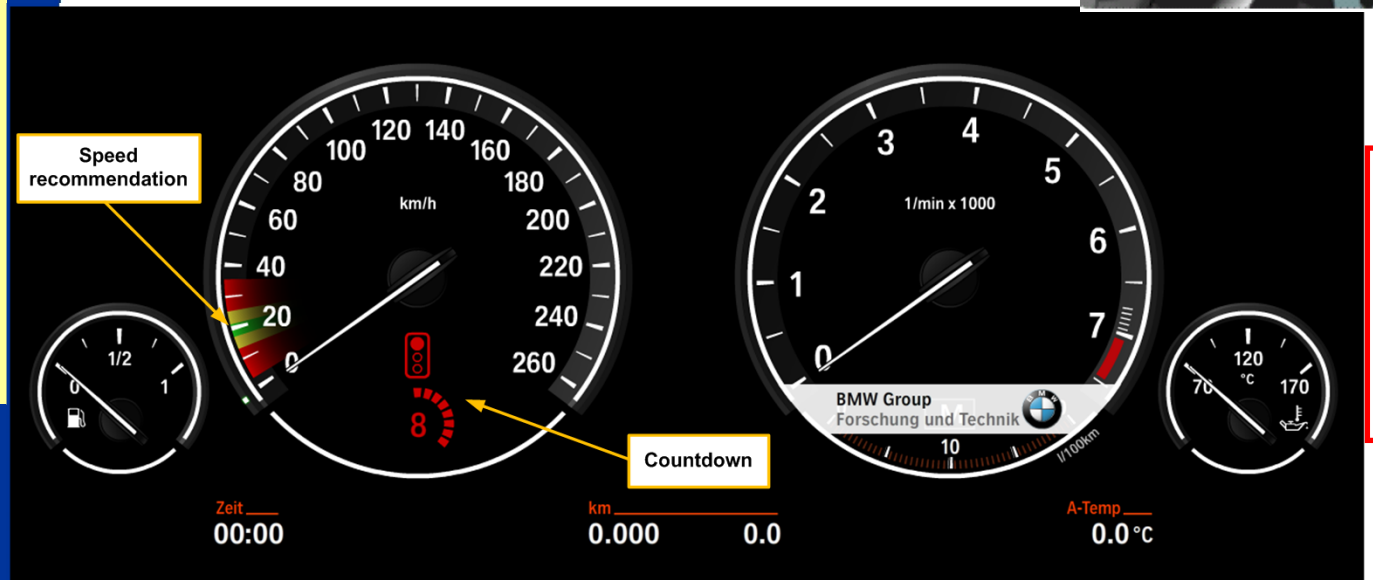
CV & Traffic Signals: Eco-Driving

Messages

"Here I am"

Signal Phase & Timing (SPaT)

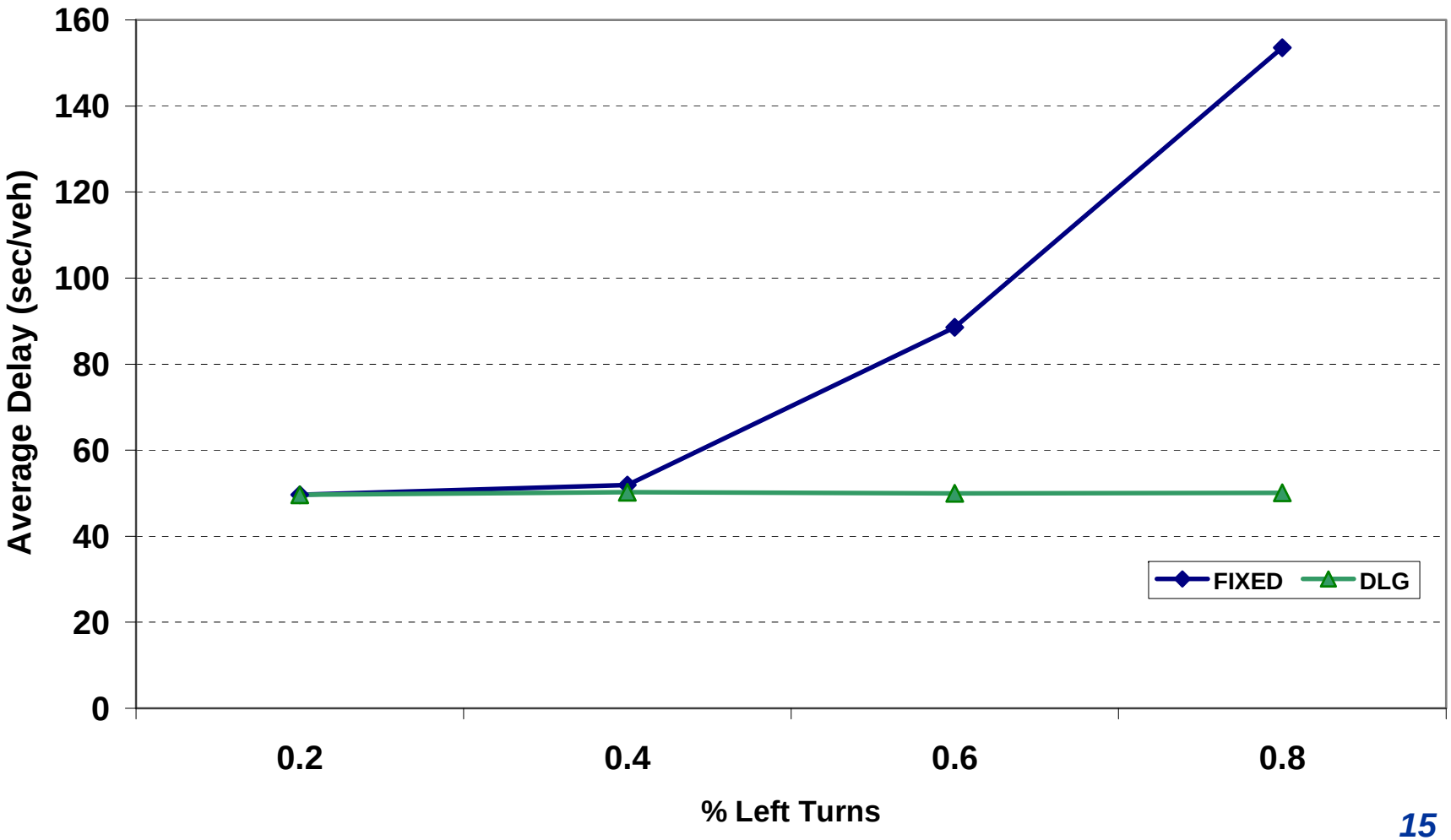
Application: Dynamic Speed Advisory (source: UC & BMW)



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