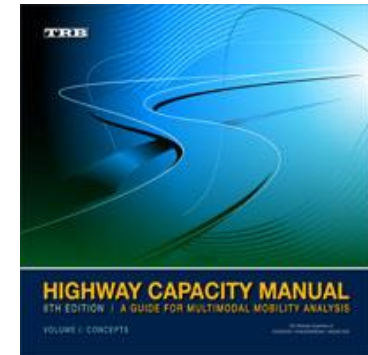
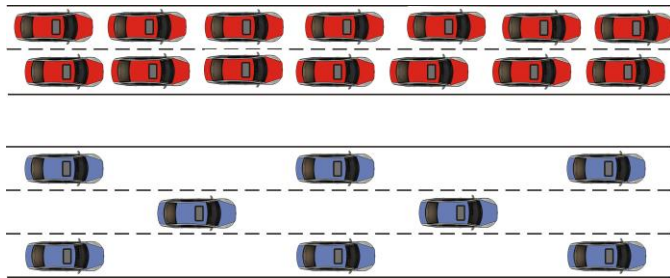


# Planning Level Roadway Capacity Analysis Adjustments for Connected and Automated Vehicles: The Future is Now



*Erik Ruehr, VRPA Technologies, Inc.*

*ITE Western & Mountain Districts Meeting*

*June 30, 2020*

*Honolulu, Hawaii*

**Planning Level Roadway Capacity Analysis Adjustments for Connected and Automated Vehicles: The Future is Now**



# Outline

- › Background Information
- › Preliminary Research Results
- › Conclusion



# Public Perception of Capacity Implications

San Diego Union Tribune. October 11, 2016

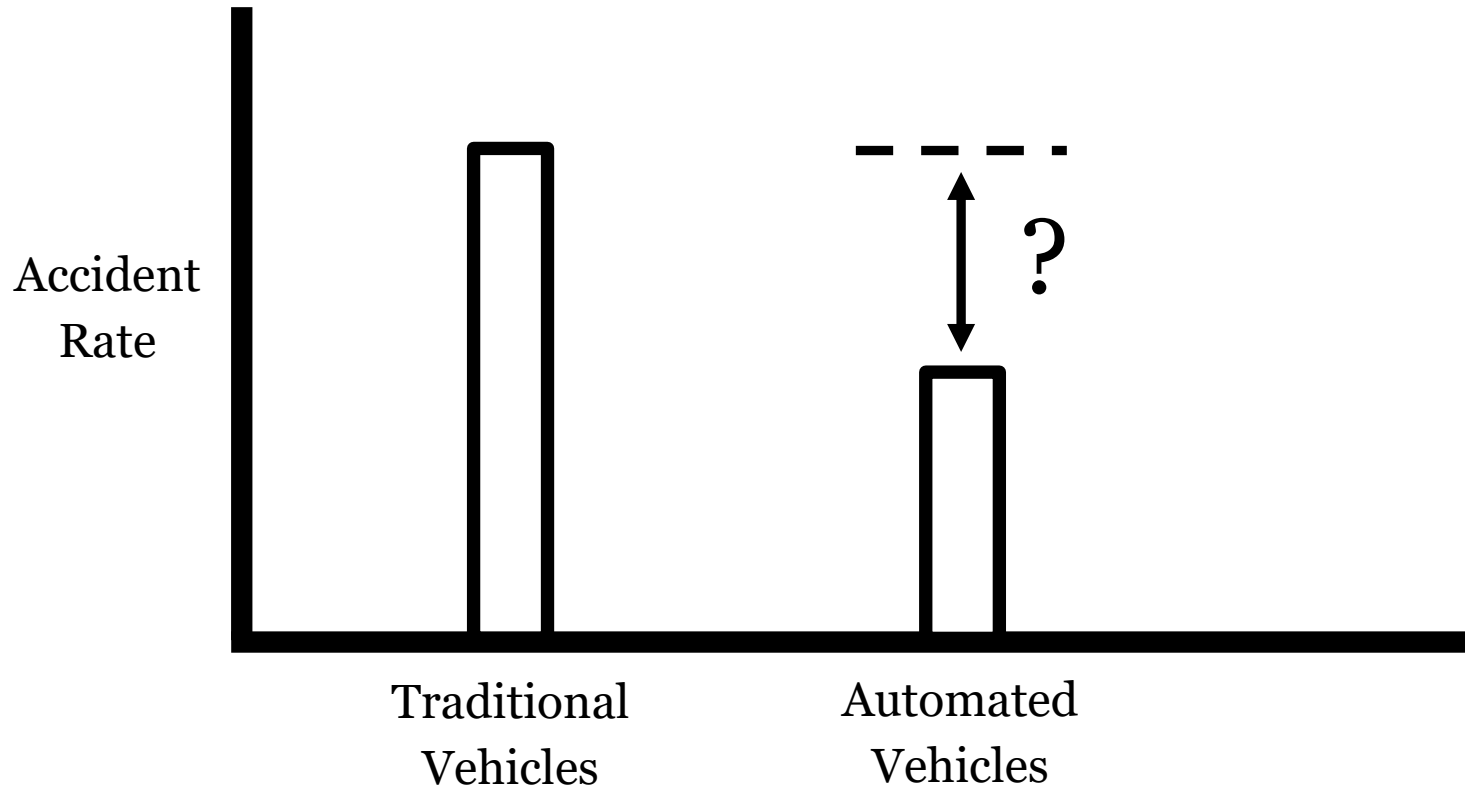
- “say no to SANDAG: reject backward looking Measure A”
- “... projects that may not be necessary in a future in which networks of autonomous vehicles reduce congestion”
- “... no one has a firm grasp on what those needs will be in five- or ten-years time”



Planning Level Roadway Capacity Analysis Adjustments for Connected and Automated Vehicles: The Future is Now



# Safety Implications of Automated Vehicles




# The Challenge of Full Automation



**Planning Level Roadway Capacity Analysis Adjustments for Connected and Automated Vehicles: The Future is Now**



# Steps in Typical Highway Capacity Manual Process

- › Observe Operations to Determine Appropriate Parameters
  - › Data Collection
  - › Data Analysis to Determine Sensitivity of Input Parameters
  - › Develop Model  
*Analysis Supplemented by Simulation*
  - › Calibrate Model Based on Observed Data
  - › Validate Model
- 
- › HCM Procedures  
Planning (**Simple**) and Operations (**Complicated**)



# Capacity Adjustment Factors for Connected and Autonomous Vehicles in the Highway Capacity Manual – Pooled Fund Study

## > **Technical Advisory Committee (TAC)**

- > **Brian Dunn, Oregon DOT**
- > **Tony Knudson, Oregon DOT**
- > Peter Calcaterra, Connecticut DOT
- > Grant Farnsworth, Utah DOT
- > Joe Hummer, NCDOT
- > Jessie Jones, Arkansas DOT
- > Jim Mahugh, Washington State DOT
- > Bill Knowles, TXDOT
- > Subrat Mahapatra, MDOT SHA
- > Maria Overton, Florida DOT
- > Brad Steckler, Indiana DOT

## > **Research Team**

- > **Kittelson and Associates**
  - > Bastian Schroeder (PI)
  - > Abby Morgan
  - > Paul Ryus
  - > Burak Cesme
  - > Anxi Jia
  - > Lake Trask
  - > Alicia Hunter
- > **University of Cincinnati**
  - > Jiaqi Ma

## > **TRB Committee on Highway Capacity and Quality of Service**

... at 70 mi/h travel speed



**2,400 pc/h/ln**

→ 1.5 seconds → 154 feet



**3,600 pc/h/ln**

→ 1.0 seconds → 103 feet

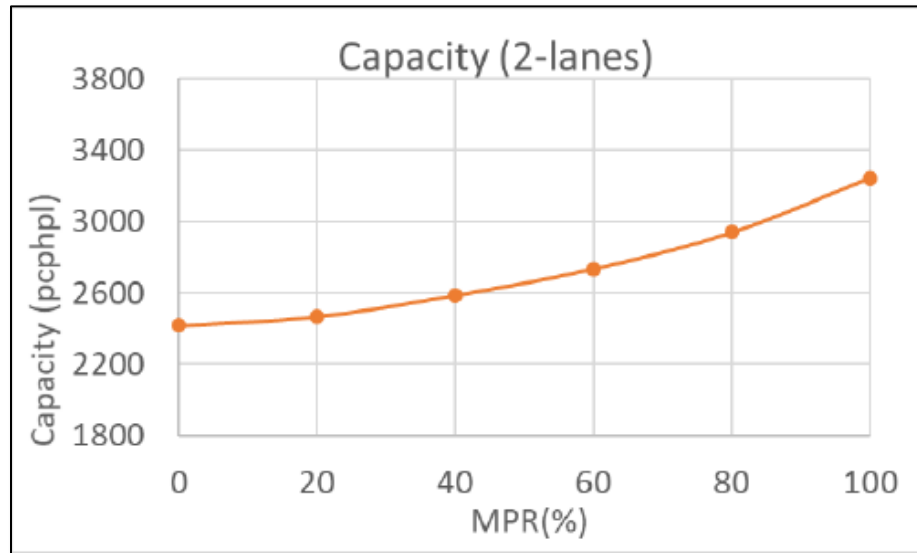


**7,200 pc/h/ln**

→ 0.5 seconds → 51 feet



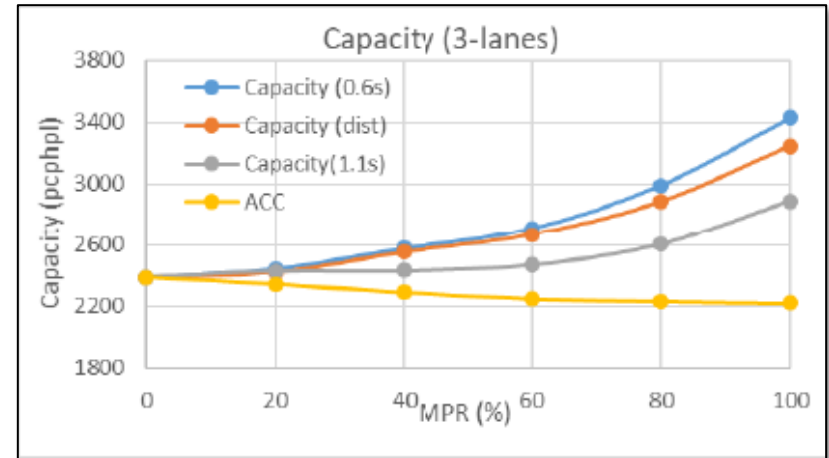
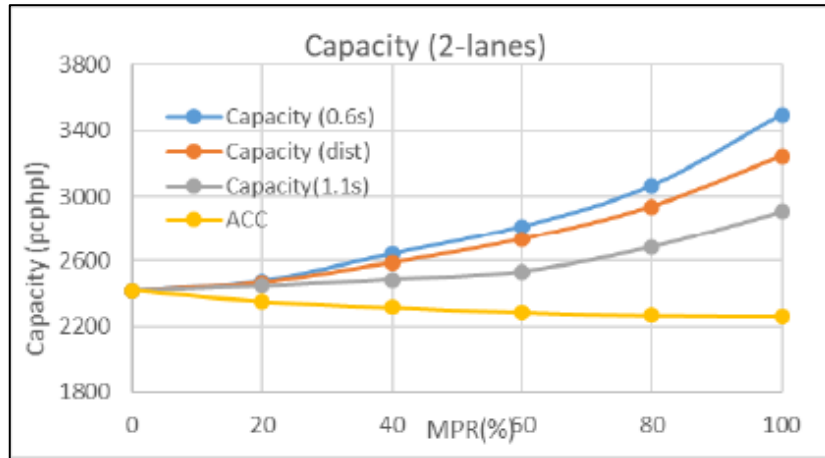
# Basic Freeway Segments → Effects of Market Penetration



**Steady Increase in  
Capacity with  
Increasing Market  
Penetration**

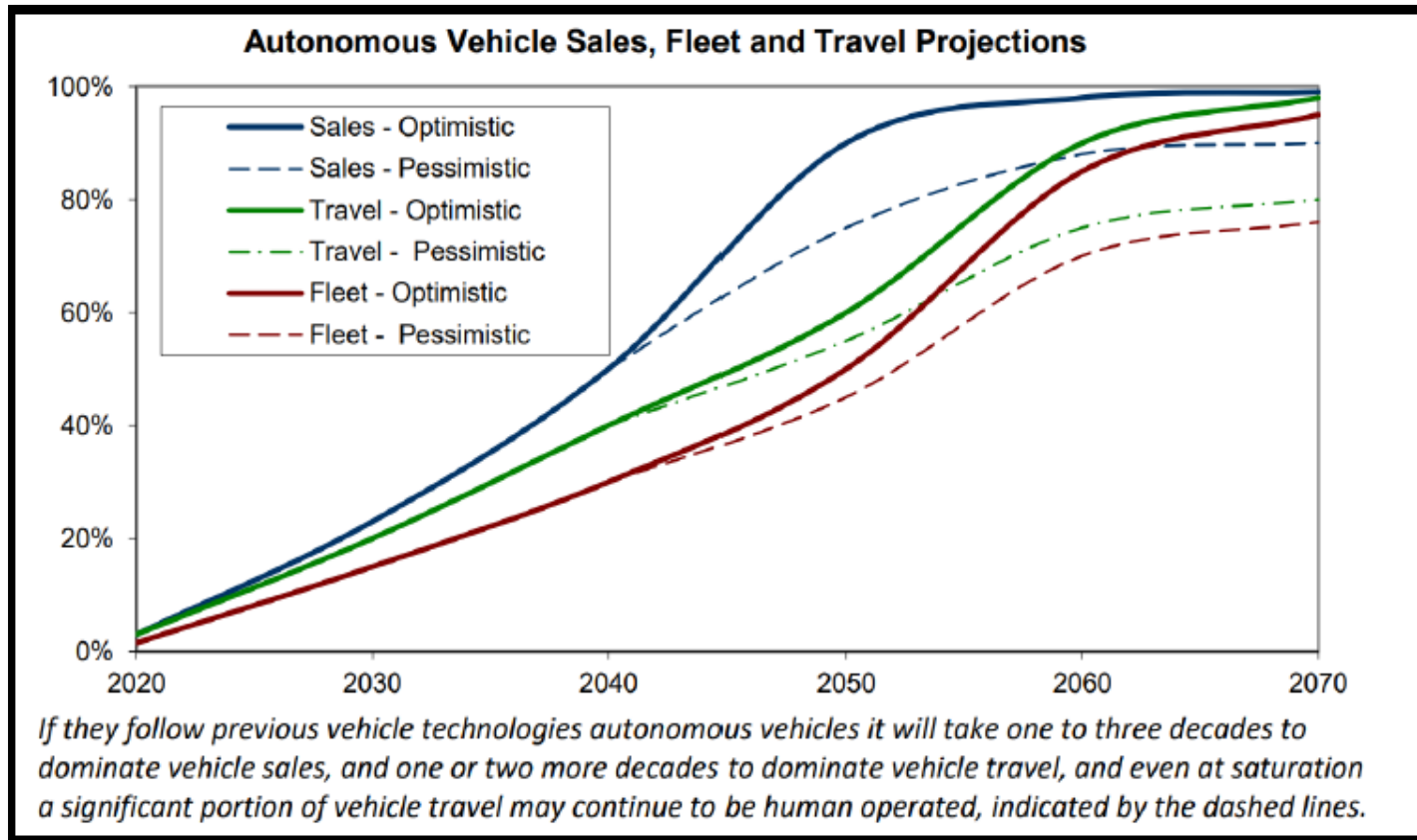
# Basic Freeway Segments

## → ACC vs CACC



**Capacity significantly lower with ACC  
(Autonomous Vehicles without Platooning)**

# CAV Adoption Timeline



# Conclusions

- › CAVs will likely increase capacities, but
  - ...not as soon as you may think
  - ...not as much as media may suggest
- › Actual capacity is a function of many factors and assumptions
- › The HCM may soon have planning-level estimates to help inform decision-making, but agencies should understand modeling assumptions
- › Dedicated CAV-Only Facilities may happen sooner

