



Managed Lanes: Challenges and Opportunities for Connected and Automated Vehicles (CAVs)



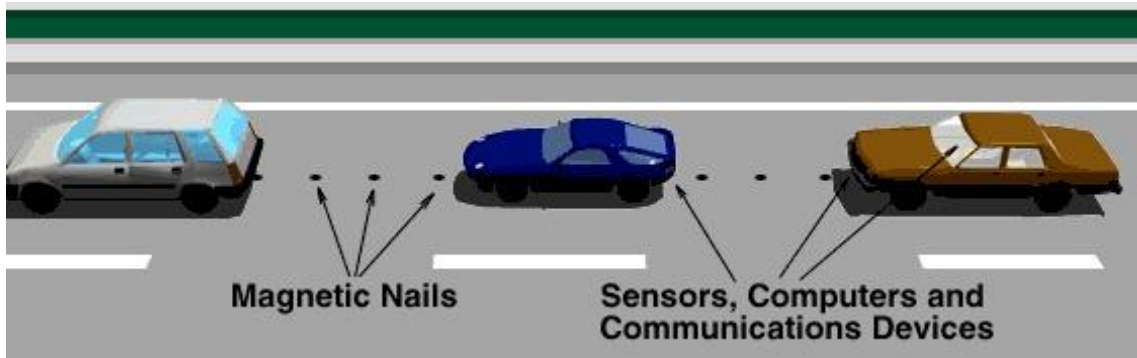
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Costa Navarino, Messinia, Greece
29-31 May 2019

Background: Automated Driving in Managed Lanes

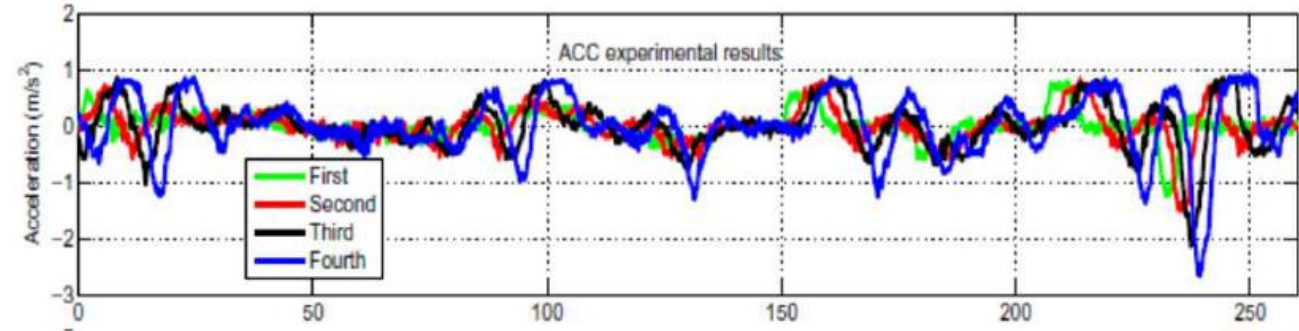
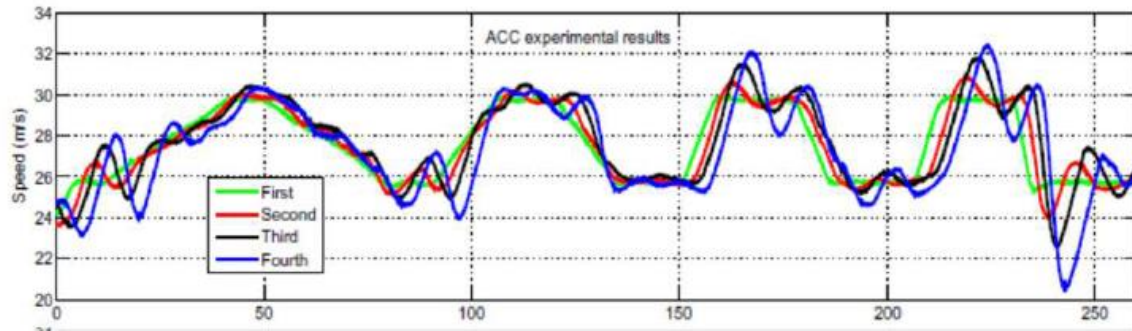
Automated Highway Systems (AHS) Demo '97 I-15 Managed Lanes, San Diego

- Automated Check-in/Check-out
- Lateral and Longitudinal Controls
- Automated merging/diverging
- Malfunction Management & Analysis

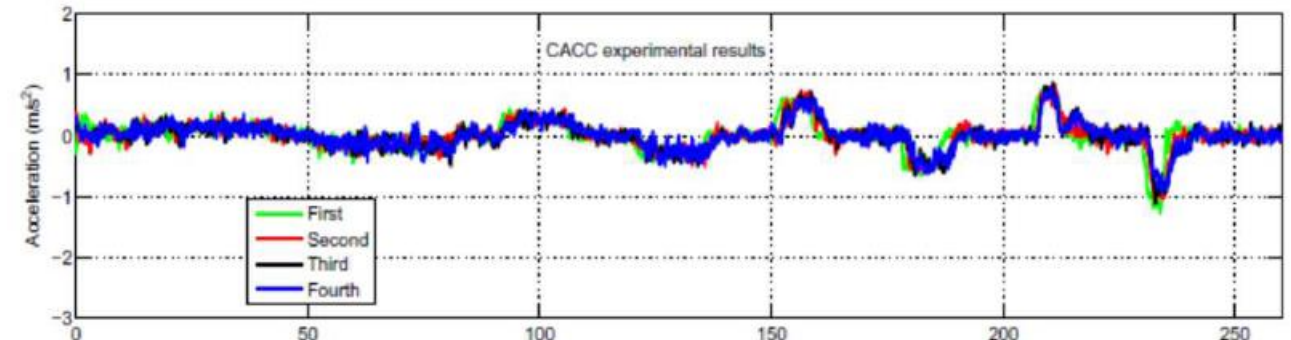
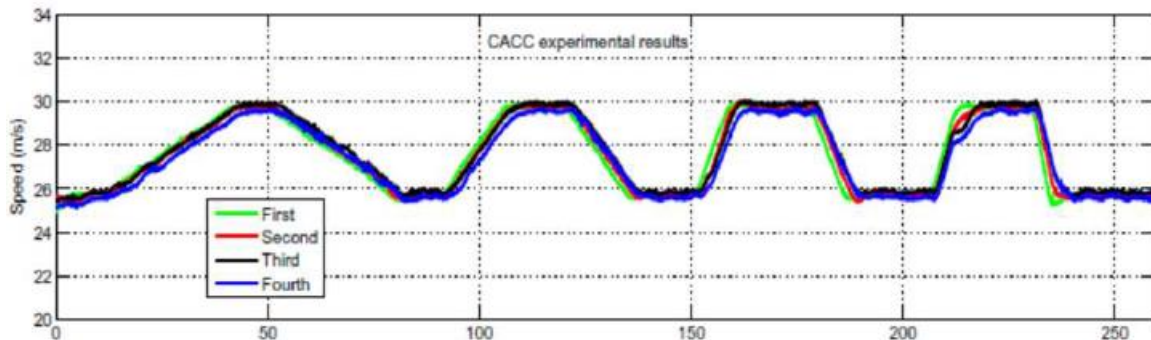


Operation of Connected Vehicles (CACC)

Field Tests



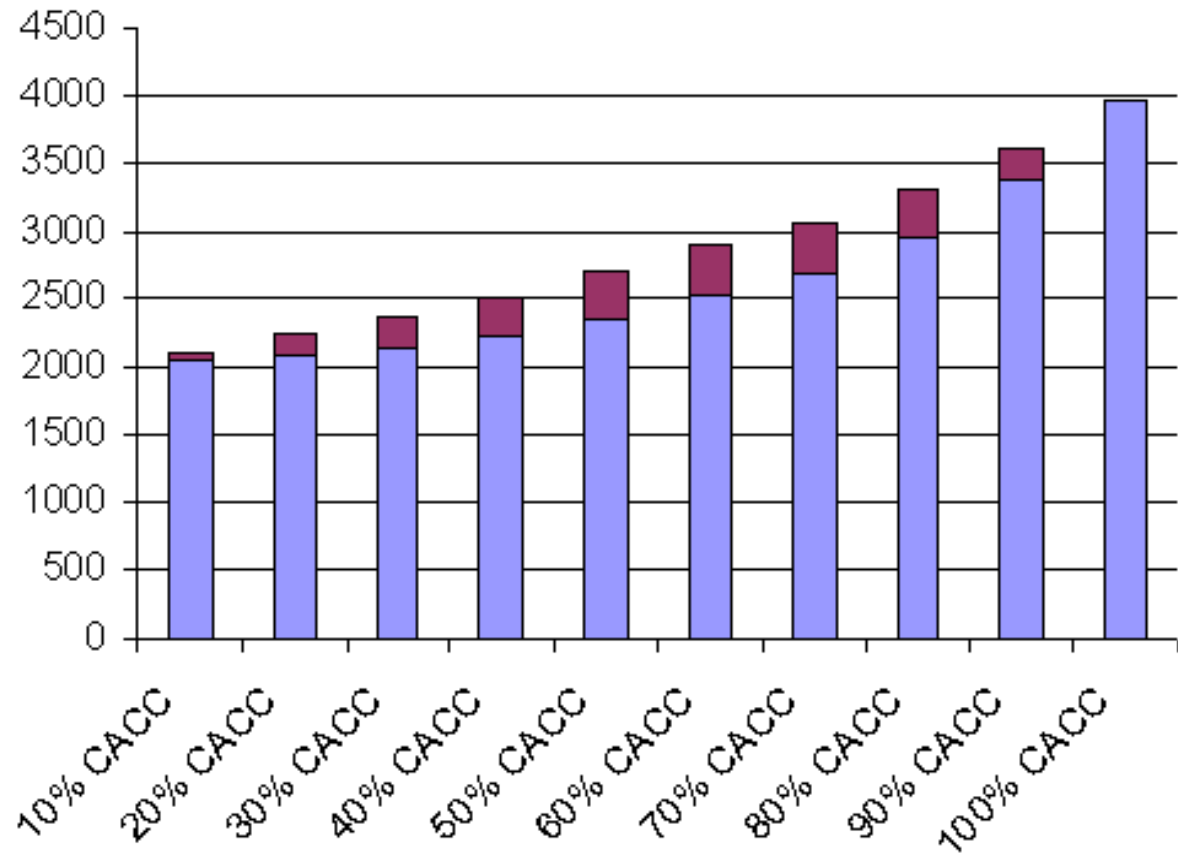
ACC: Speeds/Accelerations (*Not Connected*)



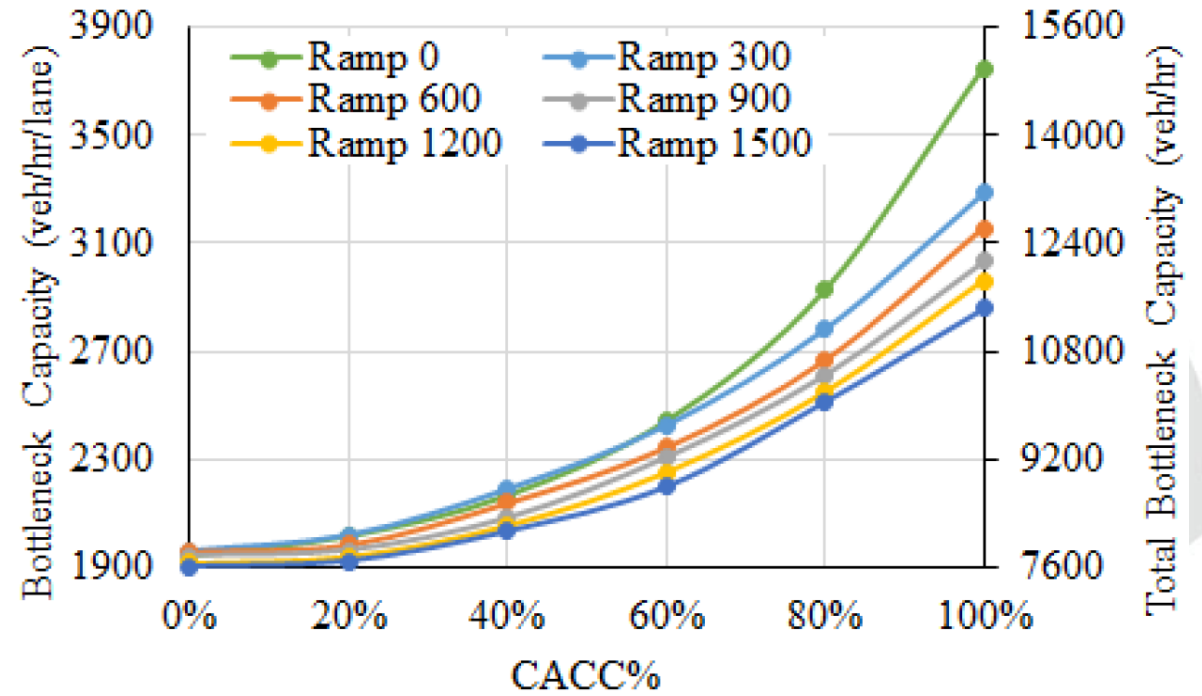
CACC: Speeds/Accelerations (*Connected*)



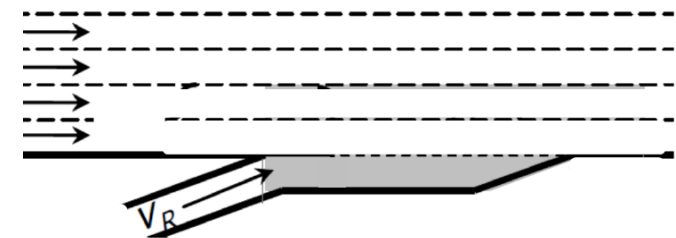
Lane Capacity vs. CACC Market Penetration



Basic Freeway Section



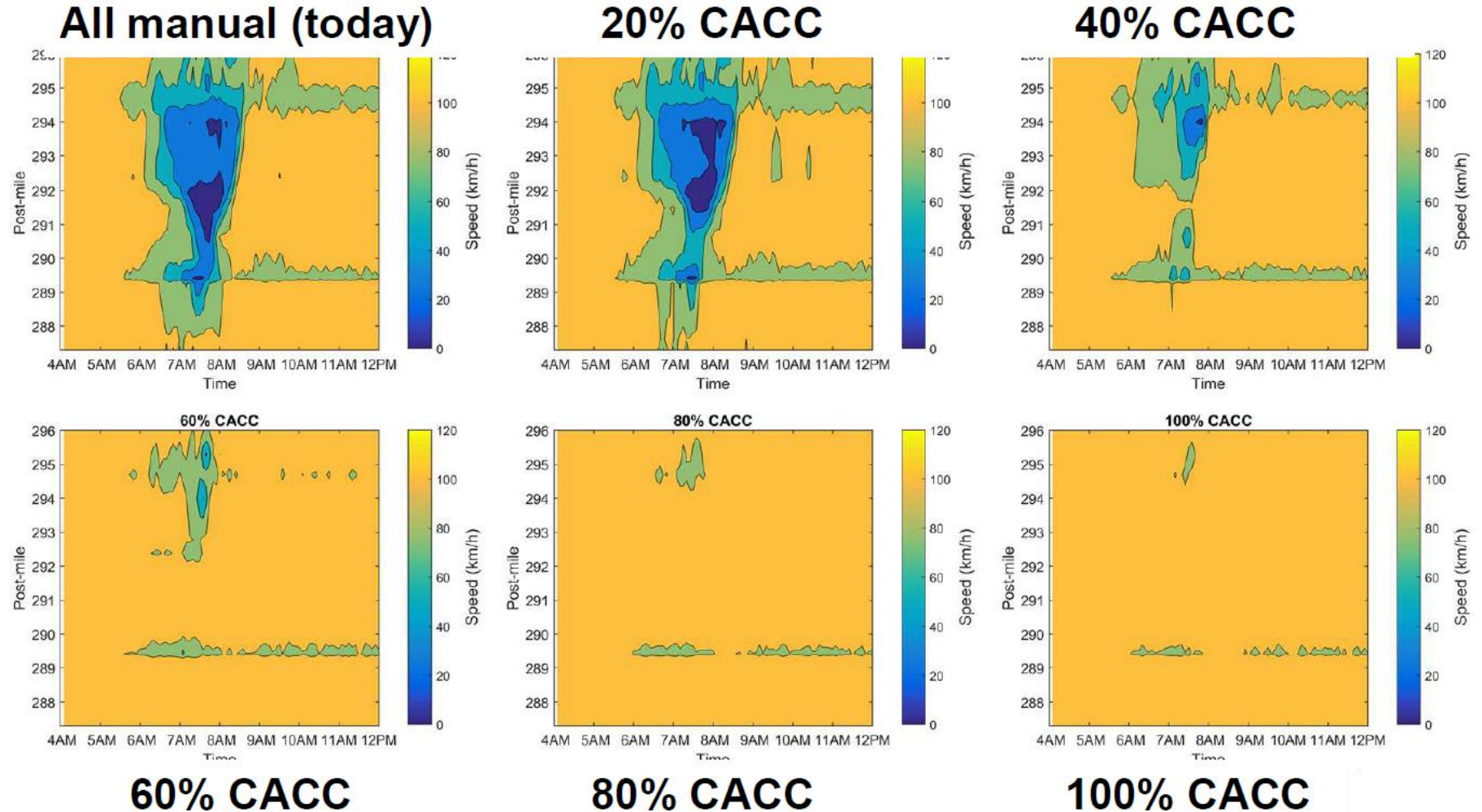
Merging Section





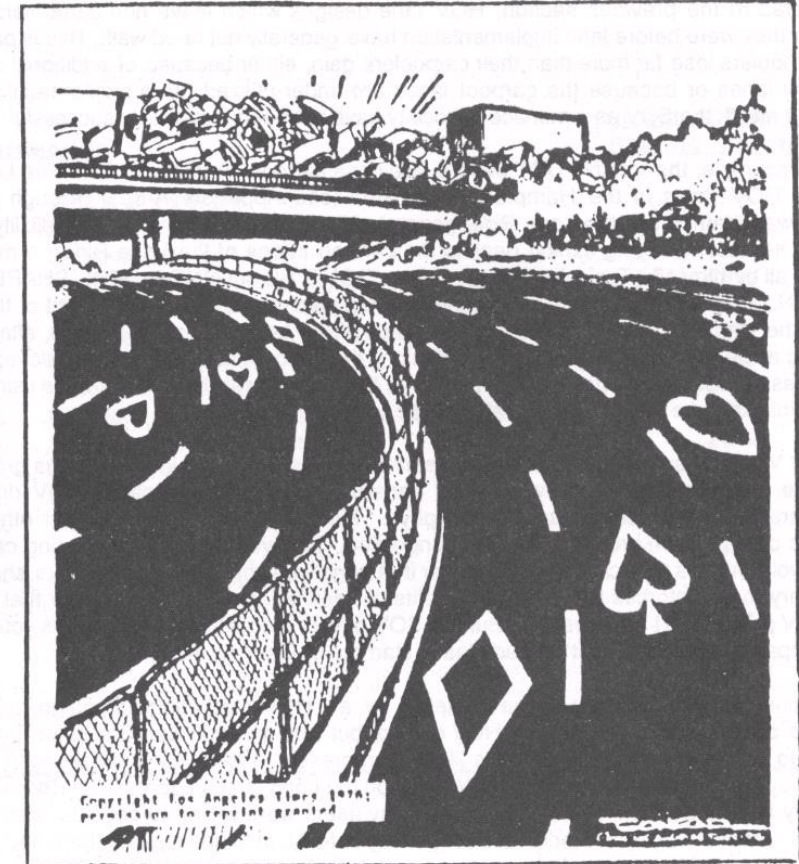
Freeway Speeds vs. CACC Market Penetration

SR-99 Freeway CA
Existing Volumes
4 am -12 noon



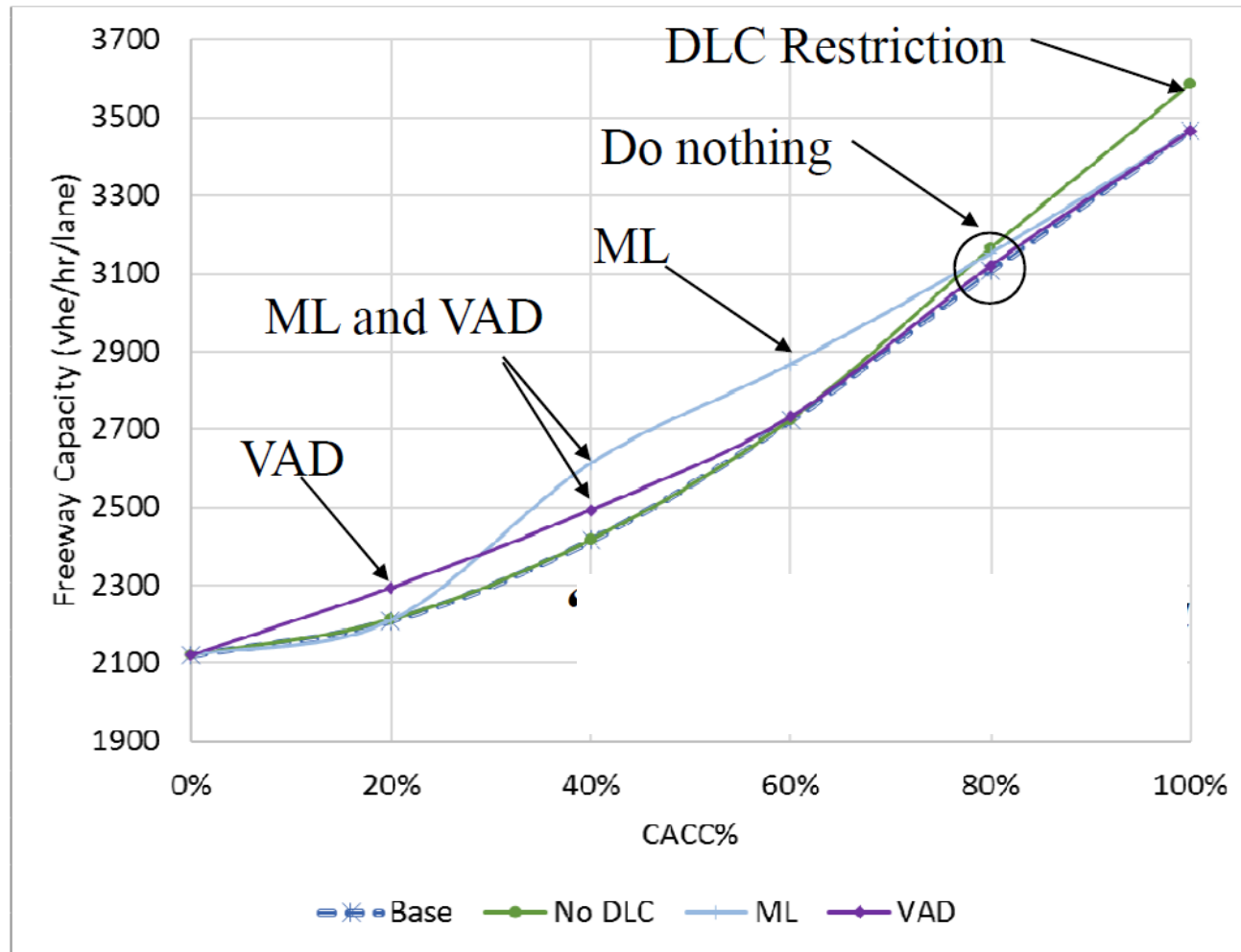
CAVs in Managed Lanes

- **Designation of selected lanes as CAVs only lanes**
market penetration (MP)
Operating conditions
- **Higher lane capacities on CAV only lanes**
Coordination with merging traffic
- **Exclusion of manually driven vehicles improves safety and facilitates testing of automation options**
- **Higher lane throughput by CAVs offers potential for user discounts**



*Introduction HOV I-10,
Los Angeles, 1974*

Impacts of Operational Strategies on Freeway Lane Capacity with CACC



Managed Lanes (ML) strategy Works best:

- **40% CACC** with 1 ML
- **60% CACC** with 2 ML
- **80% CACC** with 3 ML

VAD: Vehicles Awareness Device, DLC: Discretionary Lane Changing

Modeling CAVs: Challenges and Opportunities

- **Existing Traffic Models Lack Features to Account for Changes due to CAVs**
Simplified assumptions on CAVs car-following, lane changing models
Car-following model for mixed traffic
Interactions with manual driven vehicles
Macroscopic traffic flow relationships
- **New Models Needed to Leverage Technological capabilities, and Capture Emergent Interactions**
Operational and communication protocols
Modeling platoon streams for CAVs
 - Platoon stability*
 - Impacts of latency*