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Planning for a More Sustainable Future Symposium
October 17th 2016
Berkeley, CA
Problem Statement

Safety
33,561 highway deaths in 2012
5,615,000 crashes in 2012
Leading cause of death for ages 4, 11-27

Mobility
5.5 billion hours of travel delay
$121 billion cost of urban congestion

Environment
2.9 billion gallons of wasted fuel
56 billion lbs. of additional CO₂
Local Example: I-80 East Bay

Mean Travel Times:
25% Increase

Travel Time Variability:
50% higher
Proposed Solutions: Deep Roots

Traffic Control--Urban Streets
- 1963 Toronto: Computer control of traffic signals
- 1965-70 San Jose: On-line traffic control
- 1972 Washington DC: The UTCS Experiment
- 1972-76 London, Glasgow: On-line traffic control

Freeway Surveillance/Control
- 1963 Chicago: Ramp metering
- 1967 Detroit: Demand-Capacity Metering
- 1968 Dallas: Corridor Control
- 1970 Boston: Moving Merge Systems
- 1970 Los Angeles: Freeway Control/Incident Detection

Traveler Information
- 1940 New York: Highway advisory radio (HAR)
- late 50’s New York: Variable Message Signs
- 1969 Washington DC: Route guidance system
- 1970’s Japan (Tokyo) and Germany (Berlin): route information/guidance

Highway Automation
- 1939 World’s Fair: GM Car of the future
- 1950’s Detroit: GM studies
- 1968-73 MIT and Princeton studies on automated highways and PRT
- 1970-80: Columbus: Ohio State studies/experiments
European Approaches: ATM
US Approach: $ATDM = ATM + \text{Demand Management} \ (1)$

Example: Variable Speed Limits

I-5, Seattle, WS

Lodge Freeway, Detroit, MI
Managed Lanes

US Approach: ATDM = ATM + Demand Management (2)

Lane Management Strategy

Pricing
- Value Priced Lanes
- Toll Lanes

Vehicle Eligibility
- HOV Lanes
- Truck Lane Restrictions
- Use of HOV Lanes by Other Vehicle Groups

Access Control
- Express Lanes
- Reversible Lanes

Increasing Complexity with Active Management

Incorporate Multiple Lane Management Strategies

HOT Lanes
Multifaceted Managed Lane Facilities
Busways
Transitways
Exclusive Truck Facilities
Integrated Corridor Management (ICM)

Corridor Traffic Management & Information Vision

1988
USDOT ICM Programs

US-75 ICM Corridor, Dallas, TX

I-15 ICM Corridor, San Diego, CA
CA CC I-210: Decision Support

- **Heterogeneous data**
- **Historical data**
- **Measured $\rho, v, f$**
- **Incidents, CHP, etc.**
- **Current $\rho, v, f$ state**
- **Demand estimation**
- **Demand prediction**
- **Performance prediction**
- **Predicted OD and routes**
- **Supply management strategy**
- **Demand management strategy**
- **Data scopes**
- **Interface**
- **Normalization and fusion**
- **Actuation**
- **Strategy bank**
- **Knowledge Actuation Interface**
Connected Vehicles (CV)

Safety Applications
Mobility Applications

V2V, I2V, V2I
CV Applications: Lane Capacity

Cooperative Adaptive Crouse Control (CACC)

Capacity (veh/h/l)

10% CACC, 20% CACC, 30% CACC, 40% CACC, 50% CACC, 60% CACC, 70% CACC, 80% CACC, 90% CACC, 100% CACC
CV Applications: Traffic Signals (1)

Each vehicle/ped/bike a sensor: Here I am

MMITSS: Multi Modal Intelligent Signal System
CV Applications: Traffic Signals (2)

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

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

14% Reduction in Fuel Use
Looking Ahead: Beyond Connected Veh

- Air quality
- Automation
- Connected Veh
- ATM

Capacity

Current technologies

Safety
Example: Capacity of AHS Lane

Capacity = \( C = \frac{v \cdot n}{[n s + a(n - 1) + d]} \) veh / lane / hour

Assume \( v = 72 \text{ k/h}, s = 5 \text{ m} \). Then

<table>
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<th>( n )</th>
<th>( a )</th>
<th>( d )</th>
<th>( C )</th>
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<td>30</td>
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<tr>
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Notes:
- \( n=20 \) yields nearly 4 times today's capacity
- Capacity proportional to speed