California PATH Transportation Safety Research Program

- State of Research -

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California PATH

Presentation at
Division of Research and Innovations, Caltrans
February 3, 2010

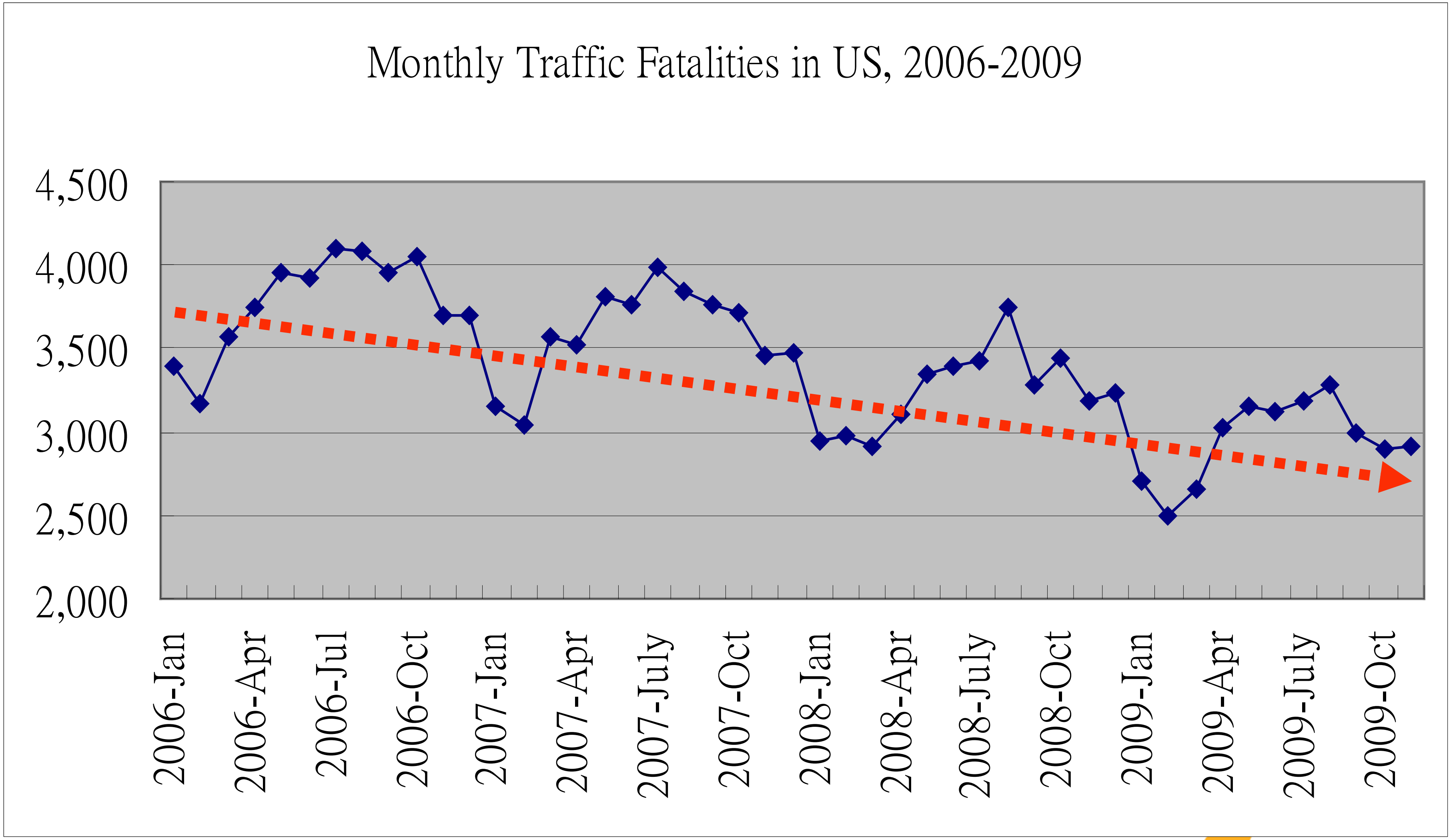
Presentation Outline

- **Transportation Safety Overview**
  - **Recent trends in safety statistics**
  - **How is California performing versus the nation?**
- **Safety Research at California PATH**
  - **Our vision and goal**
  - **Advanced research - IntelliDrive^{SM}**
  - **Highlights of past and ongoing California projects**
- **Addressing Caltrans' Needs of Safety Research**
- **Future Research Directions**

Transportation Safety Overview

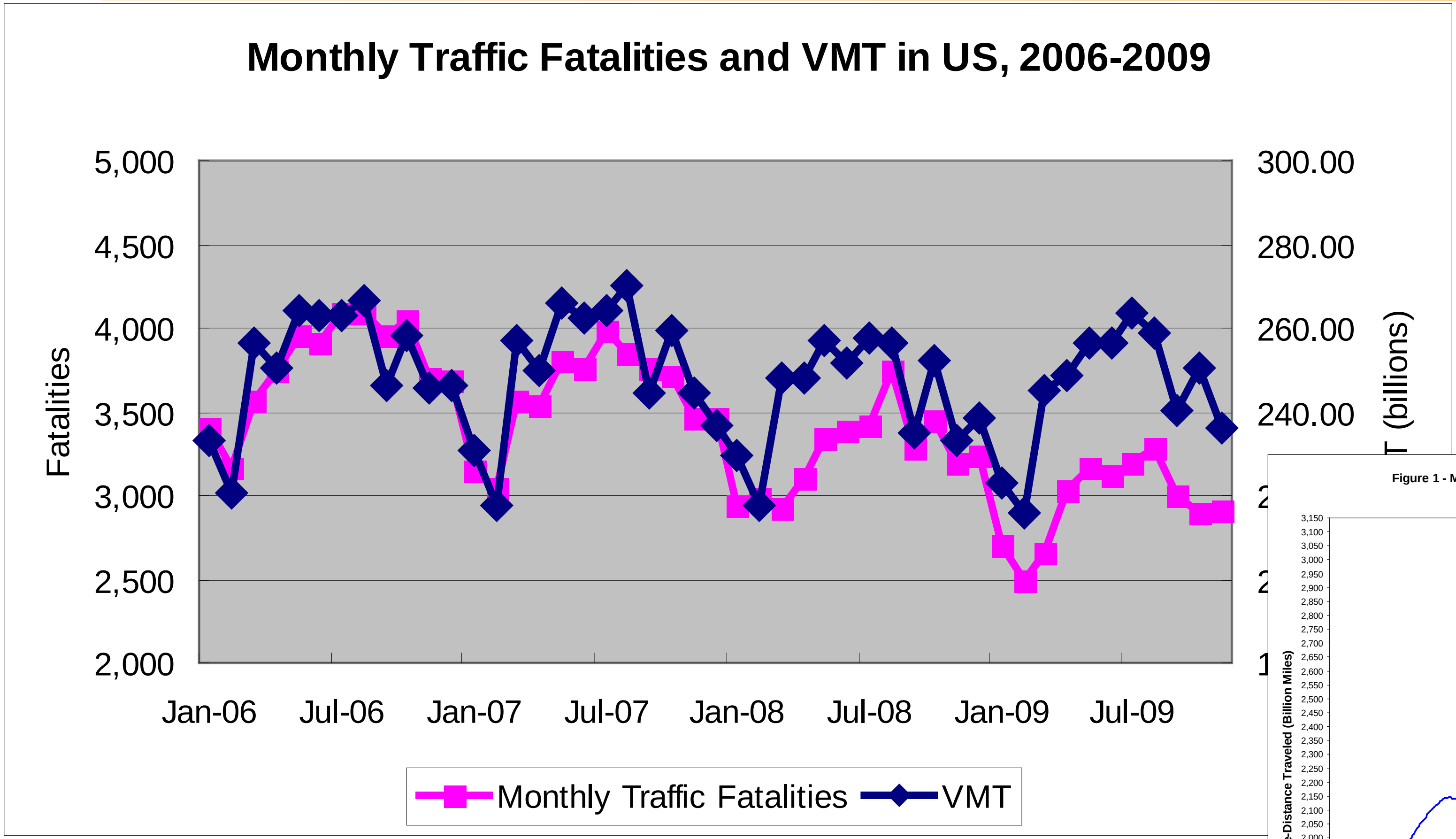
US & California

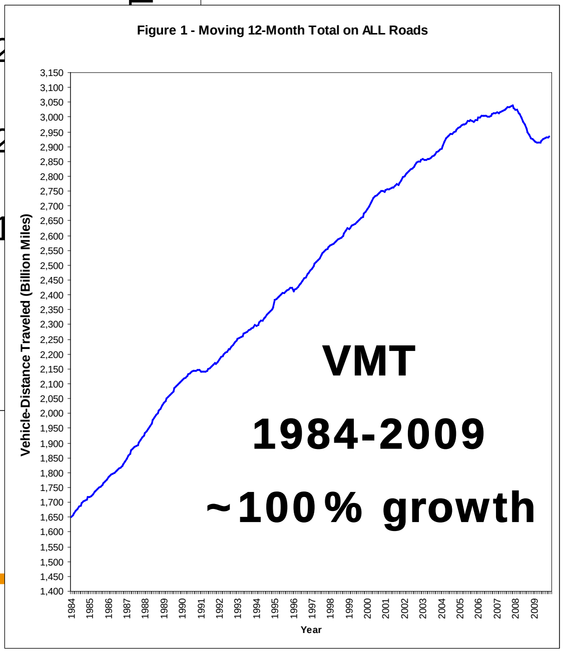
Traffic Safety is improving significantly - with continuing decline of fatalities



Source: Fatality Analysis and Reporting System

US traffic fatalities are declining with flattened growth in vehicle-miles-traveled

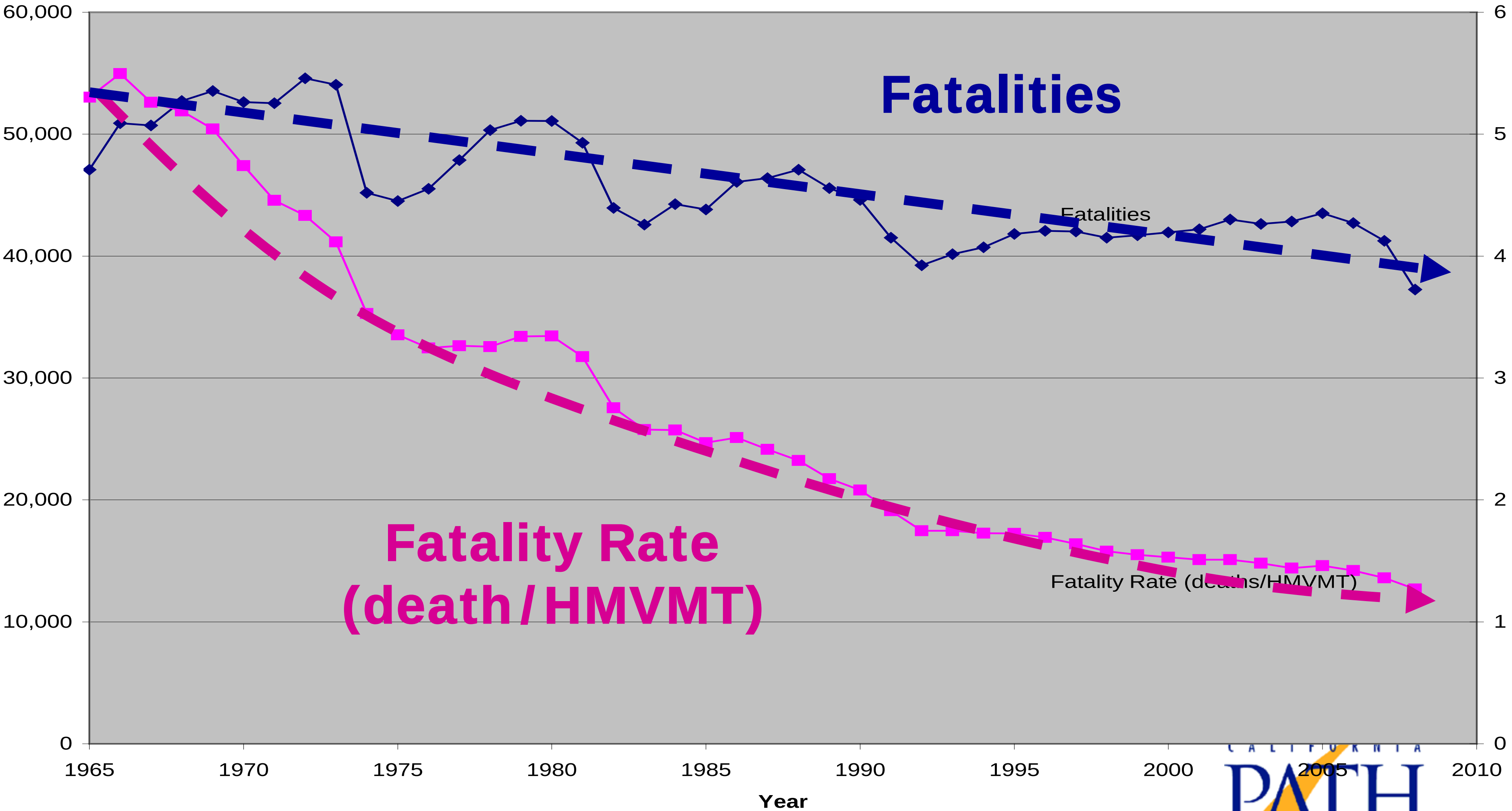




Source: FARS and FHWA

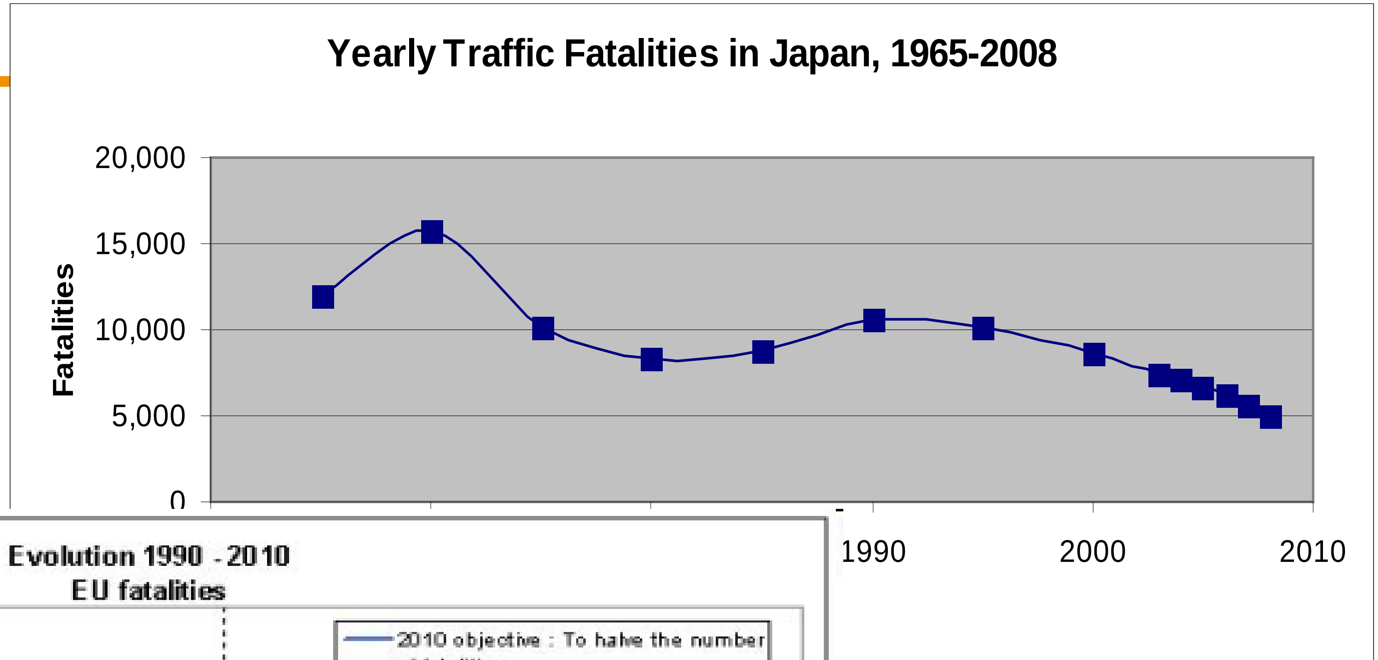
http://www.fhwa.dot.gov/ohim/tvtw/09octtvt/figure1.cfm

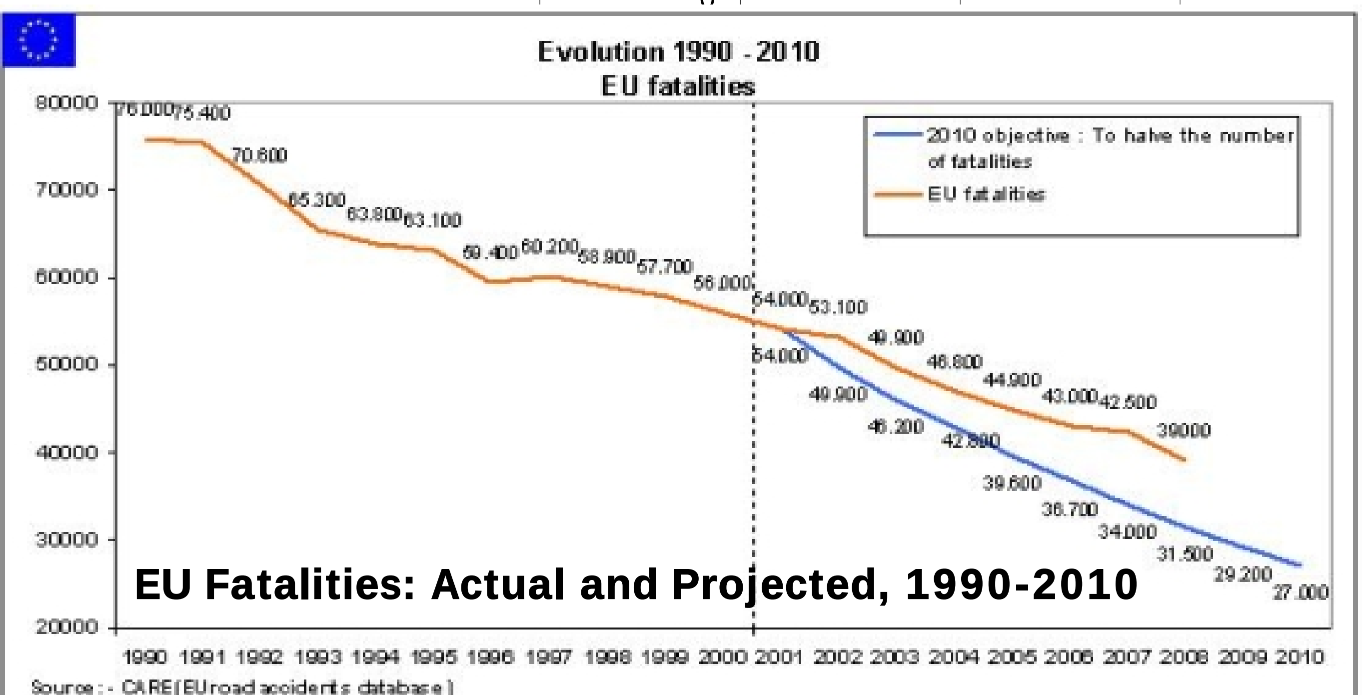
Favorable Long-Term Trends, 1965-2008 - US Annual Fatality Numbers and Rates



Source: NCHRP 17-18. Task 19

Global Trends (Japan and EU)

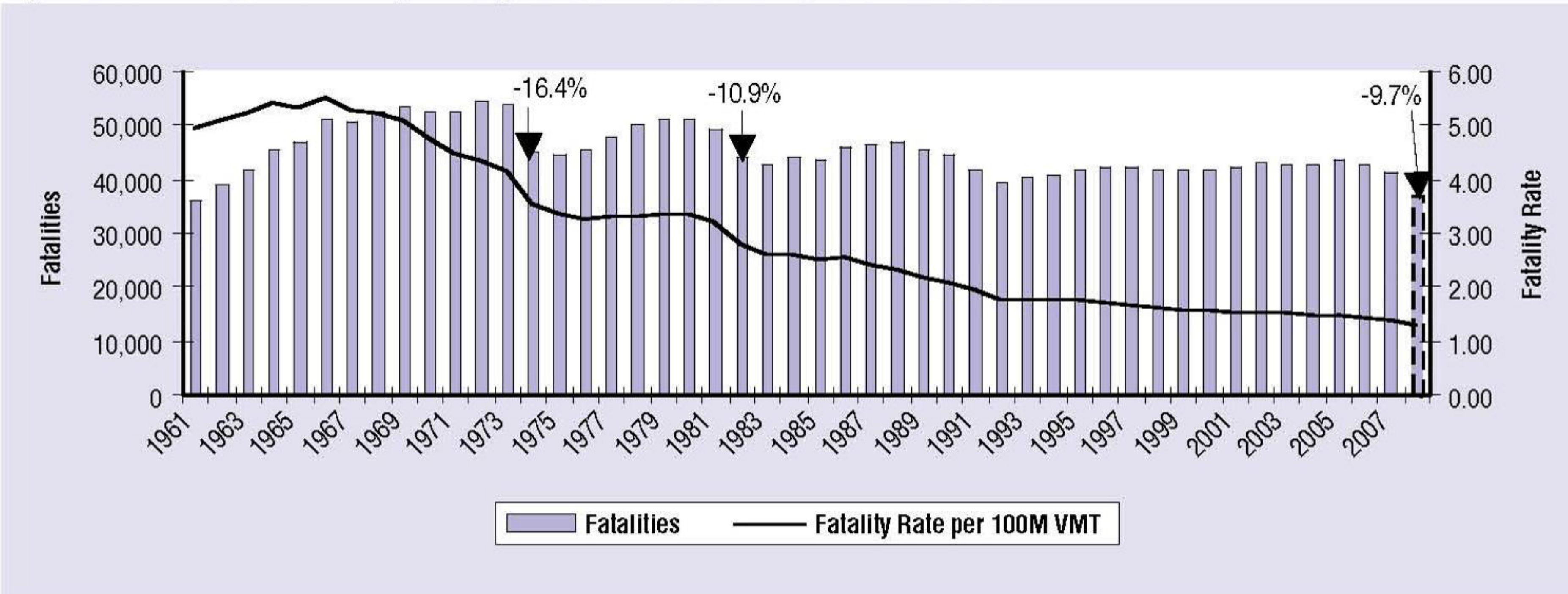




EU Fatalities: Actual and Projected, 1990-2010

Sudden Year-over-Year Decreases Happened Before : Energy Crisis (74') and High Unemployment Rate (83')

Figure 1: Fatalities and Fatality Rates per 100 Million VMT From 1961 - 2008



1961-1974: National Center for Health Statistics, HEW, and State Accident Summaries (Adjusted to 30-Day Traffic Deaths by NHTSA); FARS 1975-2007 (Final), 2008 Annual Report File (ARF); Vehicle Miles Traveled (VMT): Federal Highway Administration.

Source: DOT HS 8111 72

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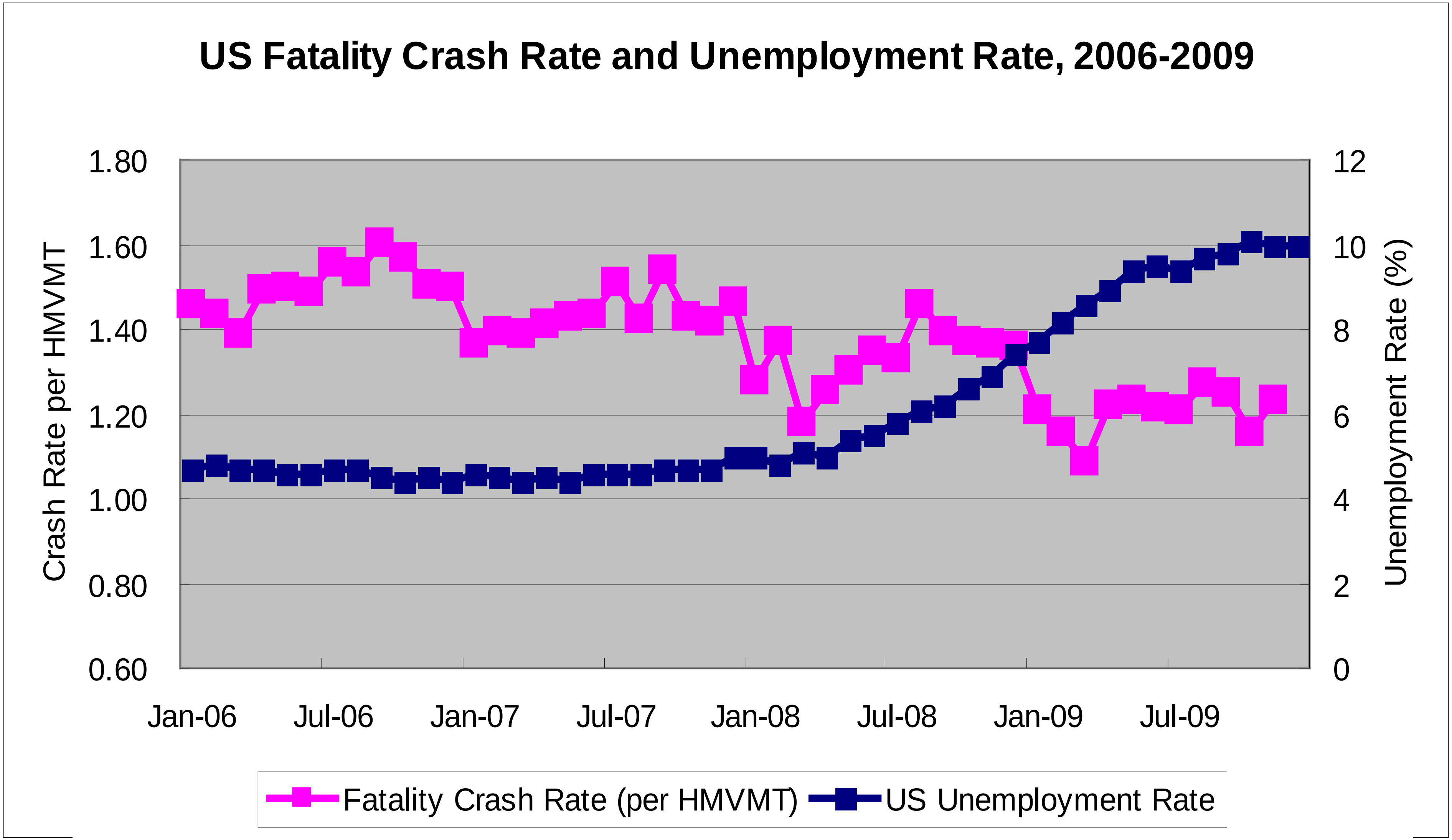
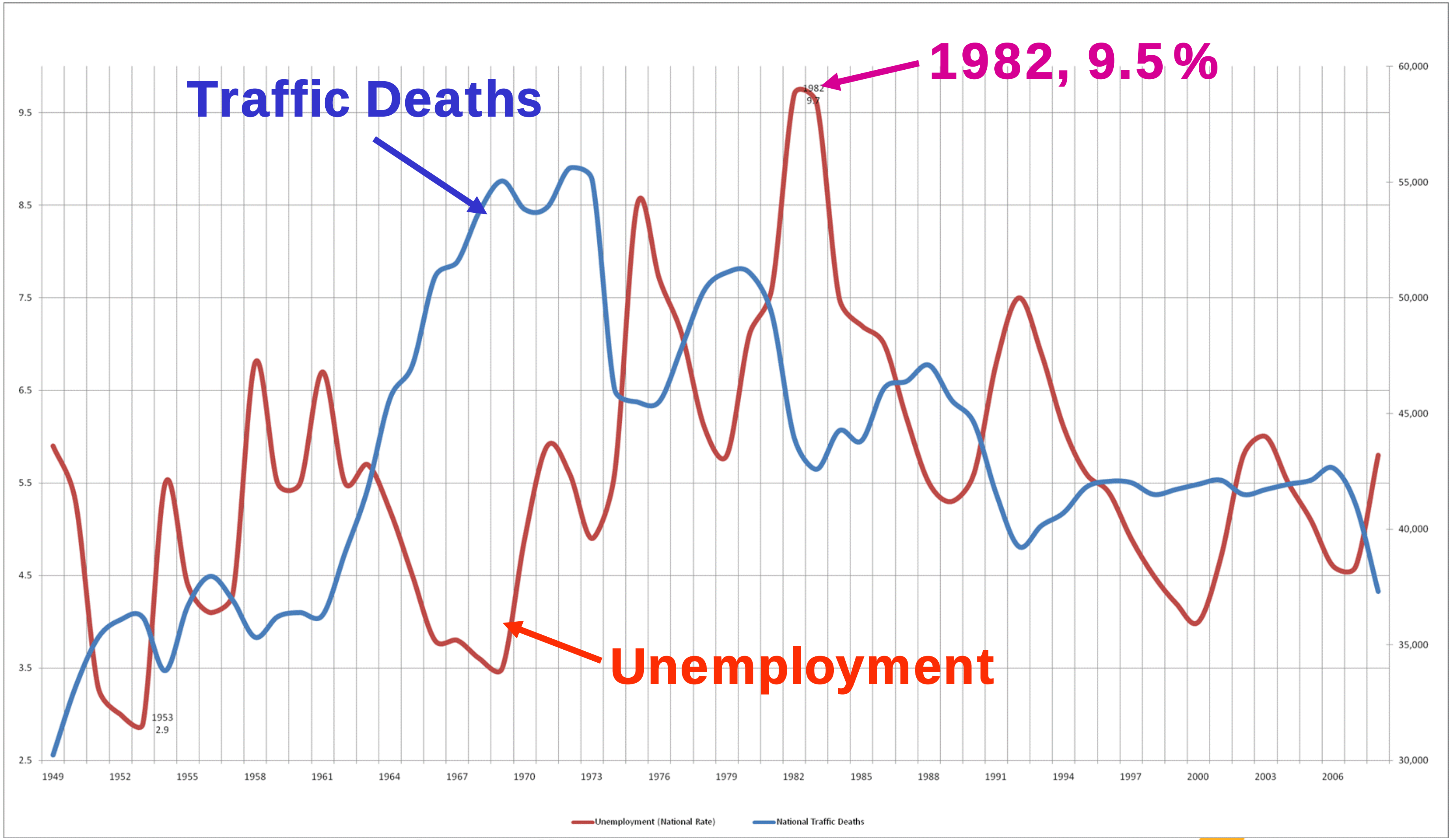
Traffic Safety is improving significantly - along with higher unemployment rate



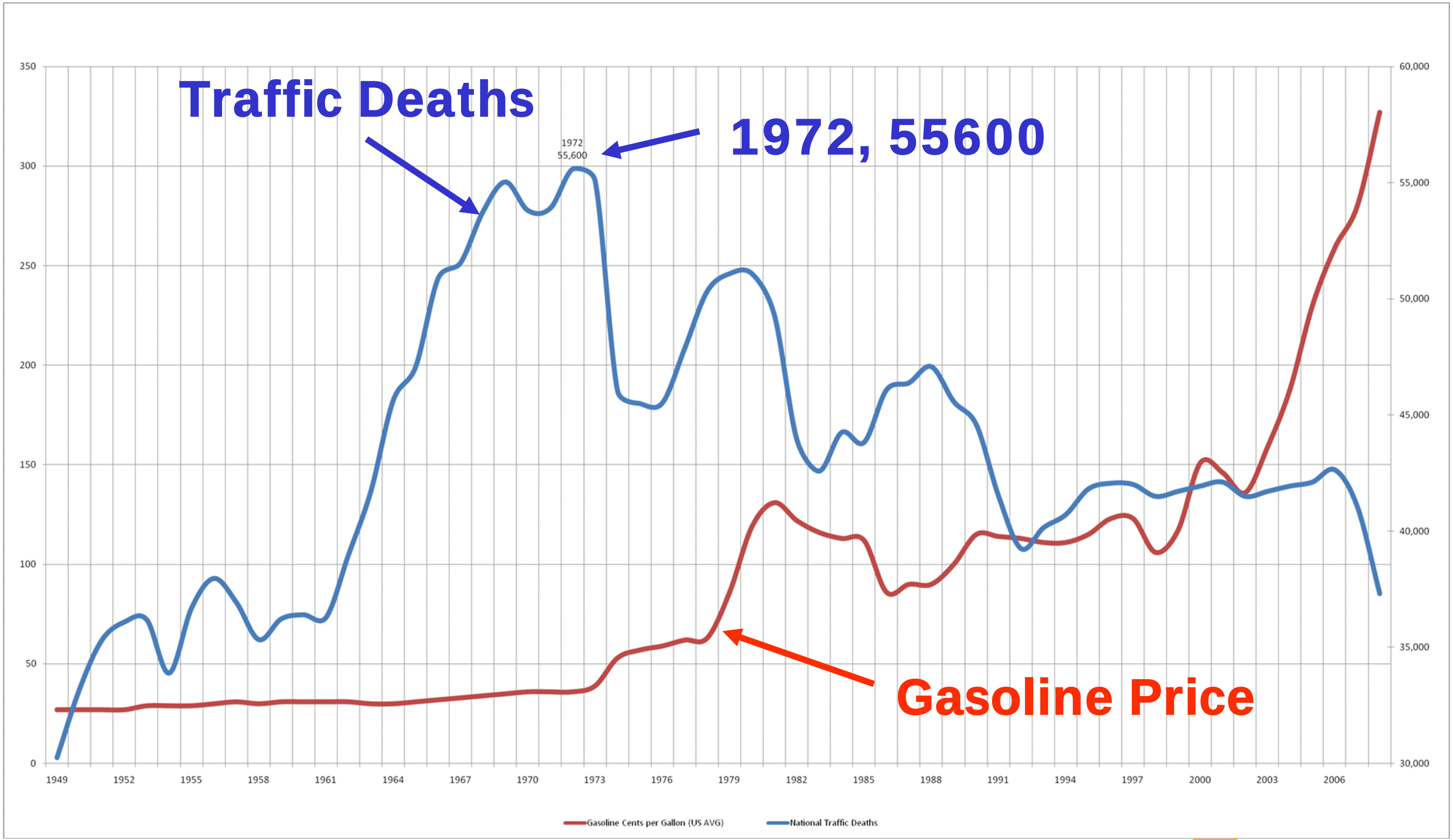
Source: Bureau of Labor Statistics and National Safety Council

National Traffic Fatalities versus Unemployment Rate (1949-2008)



Source: Roger Manning, Indiana DOT

National Traffic-Incident Fatalities versus Gasoline Price (1949-2008)



Source: Roger Manning, Indiana DOT

Transportation Safety

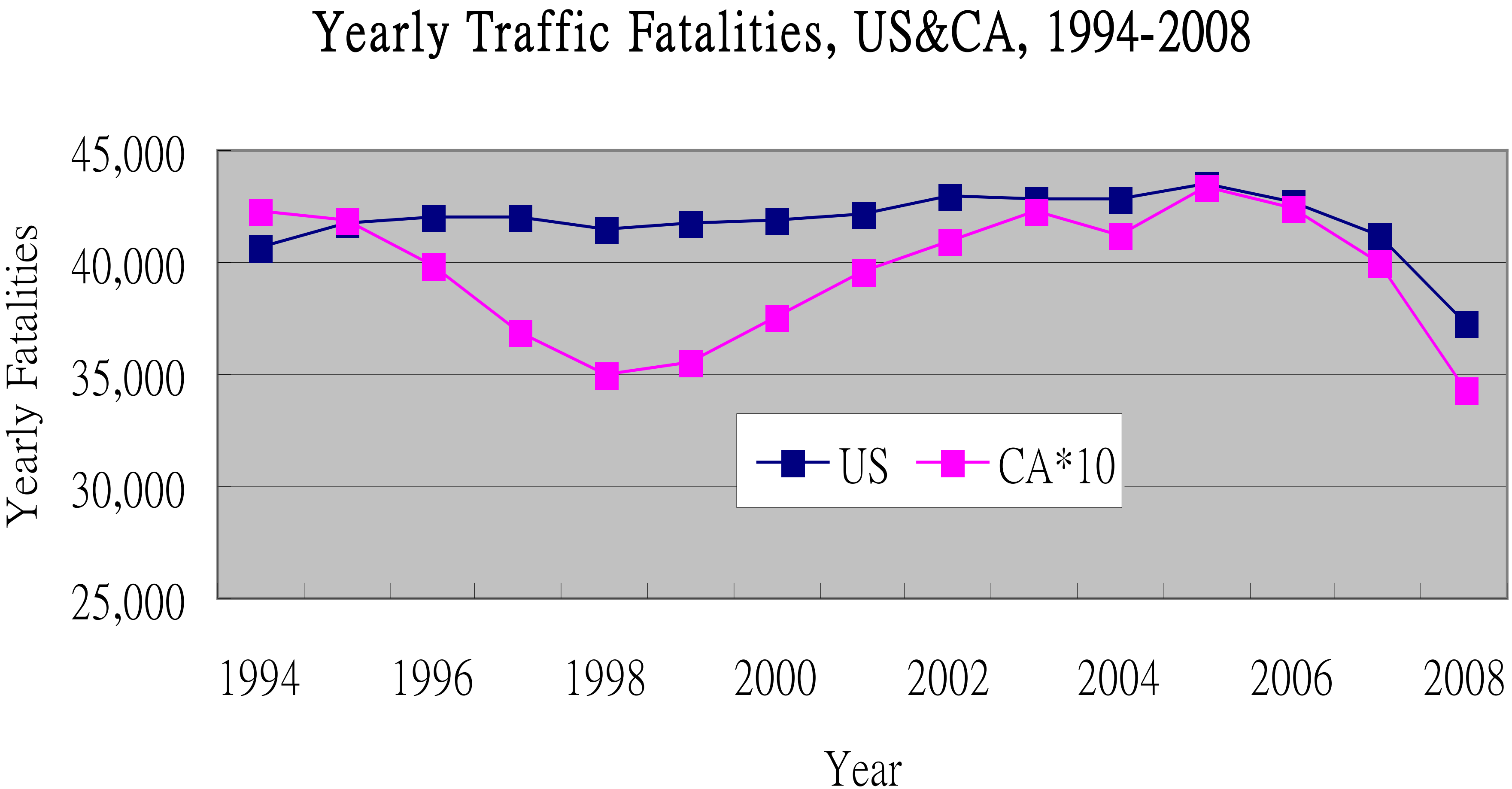
- **Safety is a primary concern for all, but it is a difficult problem.**
  - Transportation grows with economic activities
  - Human factors involved
- **Vehicle-based safety functions and technologies continue to improve.**
  - Passive restraints (seat belts and air bags) are standardized and enforced
  - Active safety systems (traction control, collision warning, lane-departure) entering market
- **A large number of organizations contributes to the battle with traffic safety**
  - DOTs, law enforcement, various agencies, manufacturers, safety advocates, standard organizations, researchers, etc.

Transportation Safety in California

CA OTS, http://www.ots.ca.gov/OTS_and_Traffic_Safety/Report_Card.asp

- **In 2008, California's traffic fatalities decreased 14.1% (3,995 vs 3,434) - reaching their lowest level since the federal government began recording traffic fatalities in 1975. The 14.1% decrease in fatalities represents the largest ever single year drop in fatalities. (FARS – Fatality Analysis Reporting System)**
- **California's 2008 Mileage Death Rate (MDR) - fatalities per 100 million miles traveled (100 Million VMT) is 1.05, much lower than the national MDR of 1.25. Of the 5 largest states in terms of total traffic fatalities, (CA, FL, TX, GA, & NC), California has the best rate. (FARS)**
- **In a report released by the Insurance Institute for Highway Safety in April 2009, California was given the highest rating in the nation for laws pertaining to DUI, Young Driver Licensing, Seat Belt Use, Child Restraint Use, Motorcycle Helmet Use, and Red Light Cameras.**

Traffic Fatalities: CA versus US



Source: FARS

Transportation Safety in California

CA OTS, http://www.ots.ca.gov/OTS_and_Traffic_Safety/Report_Card.asp

- **US motor-vehicle deaths through November of 2009 totaled 32,440.**
  - This figure is down 9% from the corresponding 11-month period in 2008.
  - The November figure for 2009 was 18% lower than the 2007 figure.

- **For the first 11 months of 2009, California motor-vehicle deaths decreased to 2,777 from the corresponding number of 3,210 in 2008, a drop of 13%.**

Source: National Safety Council

Urban 3-Year Average Fatal Crash Rates (crashes/HMVMT)

Source: Tom Welch, Iowa DOT, AASHTO Subcommittee on Safety Management Task group 4

Year	1994 to 1996	1995 to 1997	1996 to 1998	1997 to 1999	1998 to 2000	1999 to 2001	2000 to 2002	2001 to 2003	2002 to 2004	2003 to 2005	2004 to 2006	**2005 to 2007**
Louisiana	1.06	1.26	1.34	1.46	1.36	1.34	1.32	1.31	1.16	1.14	1.33	**1.55**
Nevada	1.74	1.74	1.68	1.52	1.41	1.36	1.38	1.45	1.58	1.62	1.60	**1.50**
Alaska	1.09	1.07	1.00	1.04	1.20	1.33	1.52	1.40	1.34	1.05	1.06	**1.30**
Arizona	1.65	1.67	1.51	1.48	1.42	1.44	1.44	1.36	1.29	1.23	1.30	**1.27**
Mississippi	1.42	0.93	0.45	0.09	0.06	0.02	0.01	0.53	0.89	1.09	1.09	**1.19**
California	1.00	0.94	0.88	0.81	0.81	0.84	0.87	0.88	0.87	0.89	0.89	**0.89**
USA	1.05	1.02	0.98	0.93	0.90	0.87	0.87	0.87	0.87	0.85	0.85	**0.84**
New Hampshire	0.90	0.85	0.74	0.71	0.70	0.75	0.67	0.65	0.72	0.65	0.64	**0.47**
South Carolina	0.66	0.57	0.64	0.76	0.78	0.69	0.61	0.59	0.56	0.51	0.51	**0.46**
Maine	0.86	0.79	0.87	0.87	0.80	0.72	0.59	0.38	0.22	0.15	0.30	**0.39**
Minnesota	0.72	0.67	0.67	0.63	0.61	0.59	0.60	0.60	0.57	0.55	0.50	**0.37**
North Dakota	0.62	0.50	0.53	0.54	0.64	0.52	0.54	0.59	0.73	0.73	0.46	**0.37**

Rural 3-Year Average Fatal Crash Rates (crashes/HMVMT)

Source: Tom Welch, Iowa DOT, AASHTO Subcommittee on Safety Management Task group 4

Year	*1994 to 1996*	*1995 to 1997*	*1996 to 1998*	*1997 to 1999*	*1998 to 2000*	*1999 to 2001*	*2000 to 2002*	*2001 to 2003*	*2002 to 2004*	*2003 to 2005*	*2004 to 2006*	***2005 to 2007***
South Carolina	2.88	2.88	2.88	2.84	2.63	2.64	2.61	2.76	2.69	2.89	3.13	**3.44**
Florida	3.35	3.18	3.09	3.09	3.25	2.54	2.39	2.28	3.07	3.25	3.38	**3.01**
North Carolina	2.42	2.32	2.23	2.07	2.00	1.96	2.07	2.10	2.15	2.21	2.40	**2.64**
Montana	2.39	2.50	2.55	2.55	2.43	2.43	2.54	2.63	2.55	2.42	2.33	**2.49**
Louisiana	2.68	2.56	2.48	2.47	2.55	2.56	2.46	2.27	2.31	2.52	2.55	**2.46**
California	3.92	3.66	2.39	2.26	2.15	2.11	2.16	2.19	2.20	2.22	2.26	**2.24**
USA	2.24	2.20	2.17	2.12	2.07	2.00	1.98	2.00	2.04	2.05	2.03	**2.00**
Connecticut	1.21	1.23	1.21	1.15	1.06	1.03	1.29	1.42	1.80	1.45	1.37	**1.16**
Vermont	1.58	1.66	1.55	1.61	1.52	1.31	1.08	0.94	0.97	1.04	1.16	**1.10**
Minnesota	1.70	1.62	1.62	1.63	1.63	1.51	1.49	1.48	1.49	1.37	1.25	**0.92**
Massachusetts	1.07	1.02	1.05	1.08	1.06	1.01	0.94	1.16	1.56	1.75	1.38	**0.84**
Rhode Island	1.29	1.19	1.19	1.16	1.09	1.07	1.19	1.50	1.83	1.75	1.35	**0.80**

Transportation Safety Research

at PATH

California PATH
(Partners for Advanced Transit and Highways)

- **PATH: Pioneer in ITS**
  - **Established in 1986**
  - **“Program for the Advanced Technology for the Highways” (1986-1991)**
  - **“Partners for Advanced Transit and Highways” (1991-**
  - **Founding Member Mobility 2000, ITSA**

- **Key Participant in US DOT ITS Efforts**
  - **ITS Architecture**
  - **AHS Precursor Studies, NAHSC, AHS**
  - **IVI, VII, Safe-Trip 21**

- **Strong Partnerships with Regional Agencies**
  - **MTC, MTA, SANDAG**
  - **Regional Transit Agencies and Government Alliance**

Transportation Safety Research at PATH

- **The Goal of PATH Program is to developing solutions to help solve (California's) main transportation problems**
  - **Congestion / Mobility / Productivity**
  - **Safety**

- **Safety has been and continues to be an active and focus area for research at PATH**
  - **Advanced Vehicle Control and Safety Systems (AVCSS) in the earlier years**
  - **Transportation Safety is one of the major program areas**

Vision of Safety Research at PATH

- **Conducting leading-edge applied research that is aligned with the needs of (California's) transportation systems.**
- **Leveraging technological advancements to improve transportation safety.**
- **Demonstrating and showcasing (for Caltrans) the feasibility and benefits of innovative safety applications that will lead to deployment.**
- **Developing solutions and facilitating information exchange to promote safety culture.**

Transportation Safety Research at PATH

- **Advanced Research – IntelliDrive^{SM} Related**
  - **VII and California VII**
  - **Cooperative Intersection Collision Avoidance Systems (CICAS)**
  - **Safe Trip 21**

- **Highlights of Past and Ongoing Research Projects**
  - *Highway Network Safety Assessment*
  - *Specific Safety Applications (pedestrian, work zone, etc.)*
  - *Evaluation of safety countermeasures (speed enforcement, red light running. etc.)*
  - *Driver Behaviors*

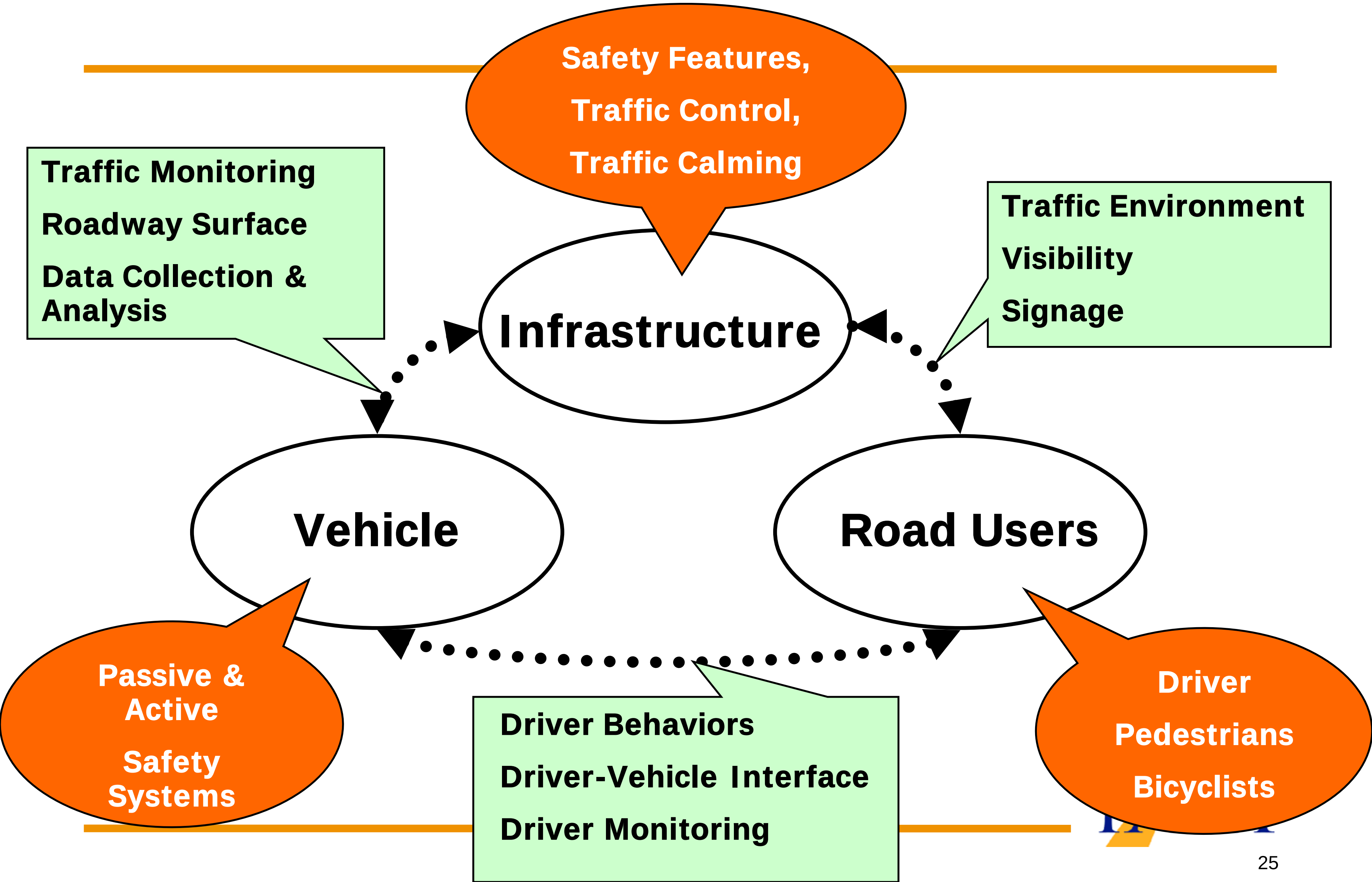
Advanced Safety Research

Jim Misener
California PATH

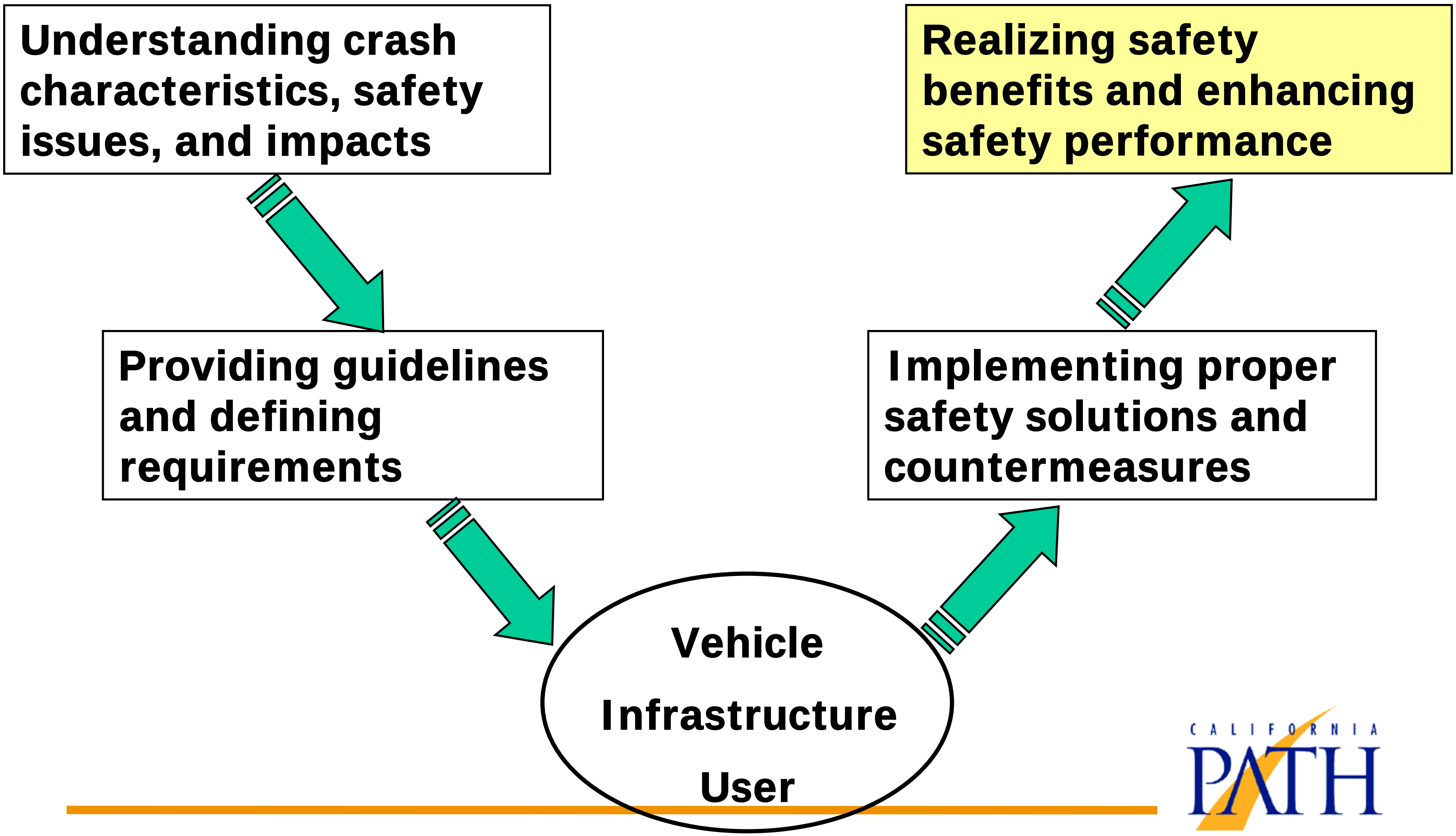
Vehicle-Infrastructure Cooperative Systems

- **TO 5202-6202**
  - **CACC - Cooperative Adaptive Cruise Control (USDOT, Nissan, Caltrans)**
- **TO 5214-6214**
  - **ITS Roadside-Vehicle Communication in Highway Setting**
- **TO 5217-6217**
  - **VII California**
- **TO 5600-5601**
  - **IDS - Intersection Decision Support (USDOT + Caltrans)**
- **TO 6607-6608**
  - **CICAS-SLTA+TSA - Cooperative Intersection Collision Avoidance Systems (USDOT + Caltrans)**
- **TO 6615**
  - **Safe Trip 21 (USDOT + Caltrans)**
- **TO 6224**
  - **Selected Mobility Applications for VII (USDOT + Caltrans)**

Elements in Transportation Systems



Systematic Approach for Safety Research



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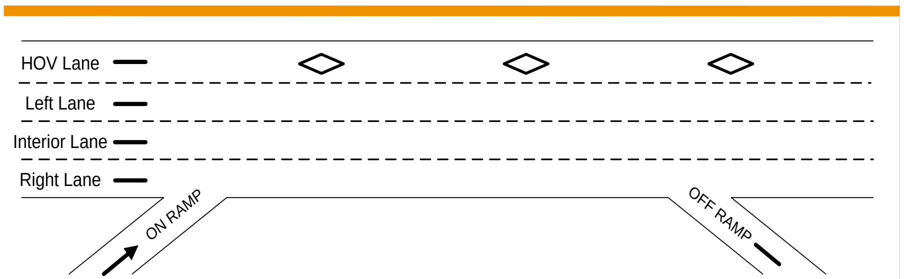
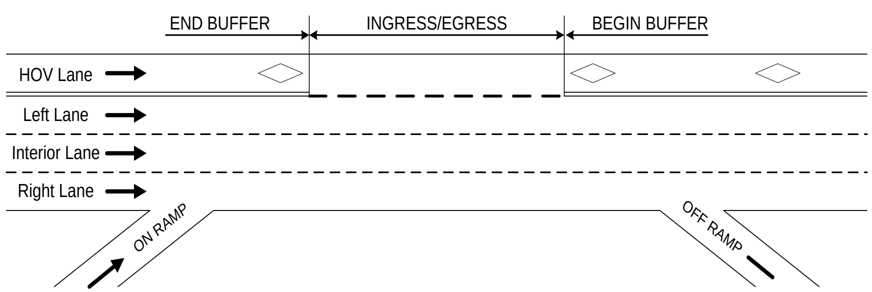
Highway System Safety Assessment

- **TO 5215-6215**
  - **Methods for Identifying High-Collision Concentration Locations (HCCL)**
- **TO 6600**
  - **Countermeasures (Auxiliary Lanes) for Highway ramps/Junctions**
- **TO 6601**
  - **Safety of HOV Ingress/Egress with Limited Access**
- **TO 6602**
  - **Wet Weather Collisions**
- **TO 6218**
  - **Skid Resistance and Pavement Safety (OGAC) Effectiveness**
- **TO 6610**
  - **Data Analysis for SHSP**

HOV Lane Configurations



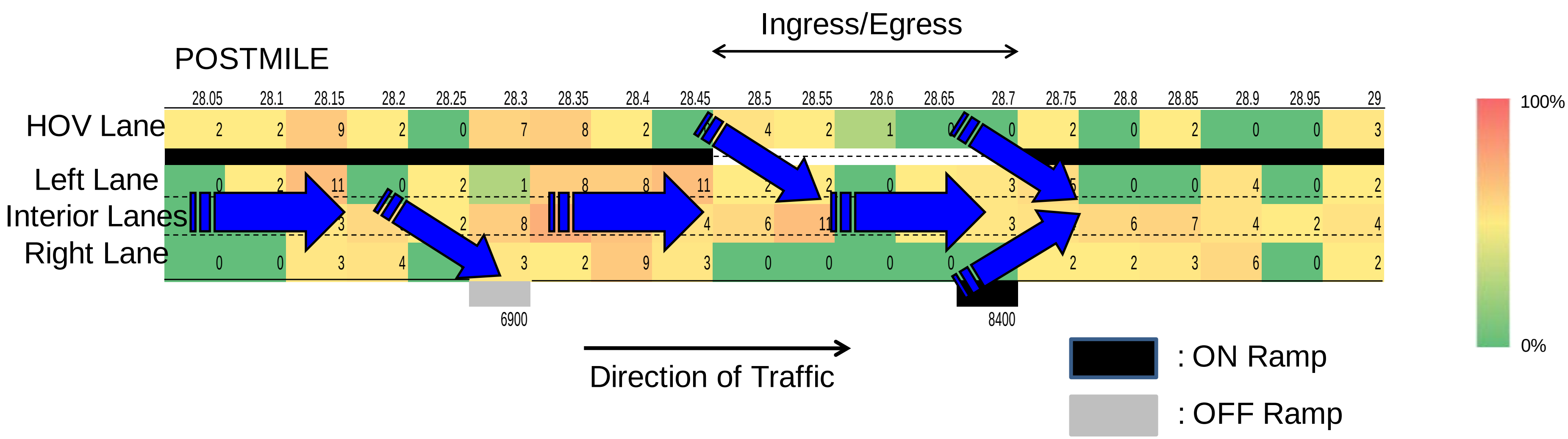
Continuous Access
(Peak-Hour Operation)

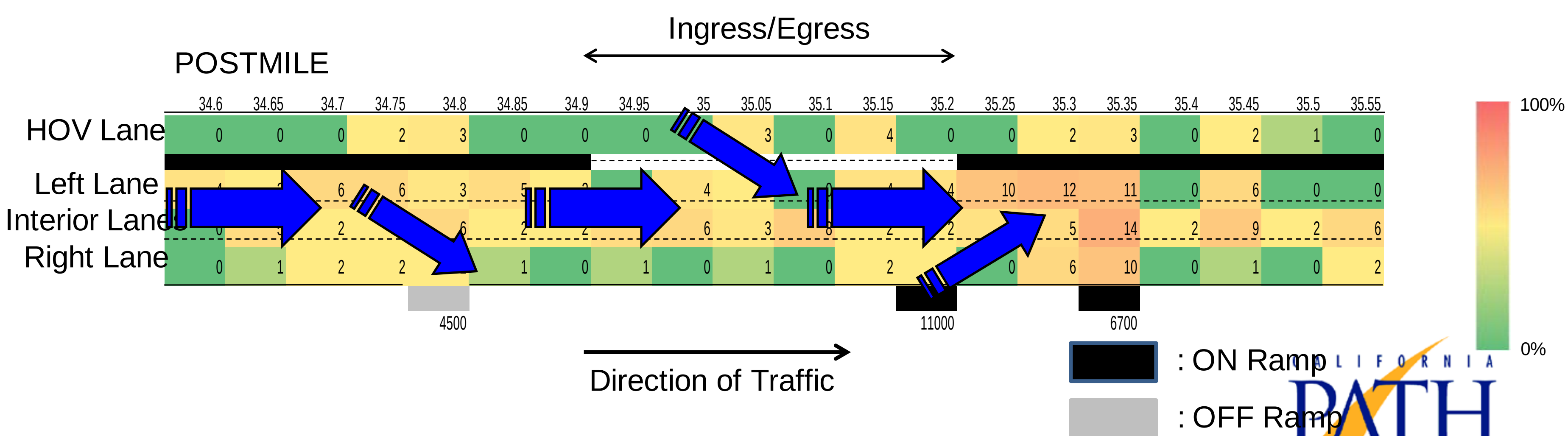


Limited Access
(24-Hour Operation)

An Illustration of Traffic Phenomenon near HOV Ingress/Egress

Spatial Distribution of Collisions (I-210E, LA)





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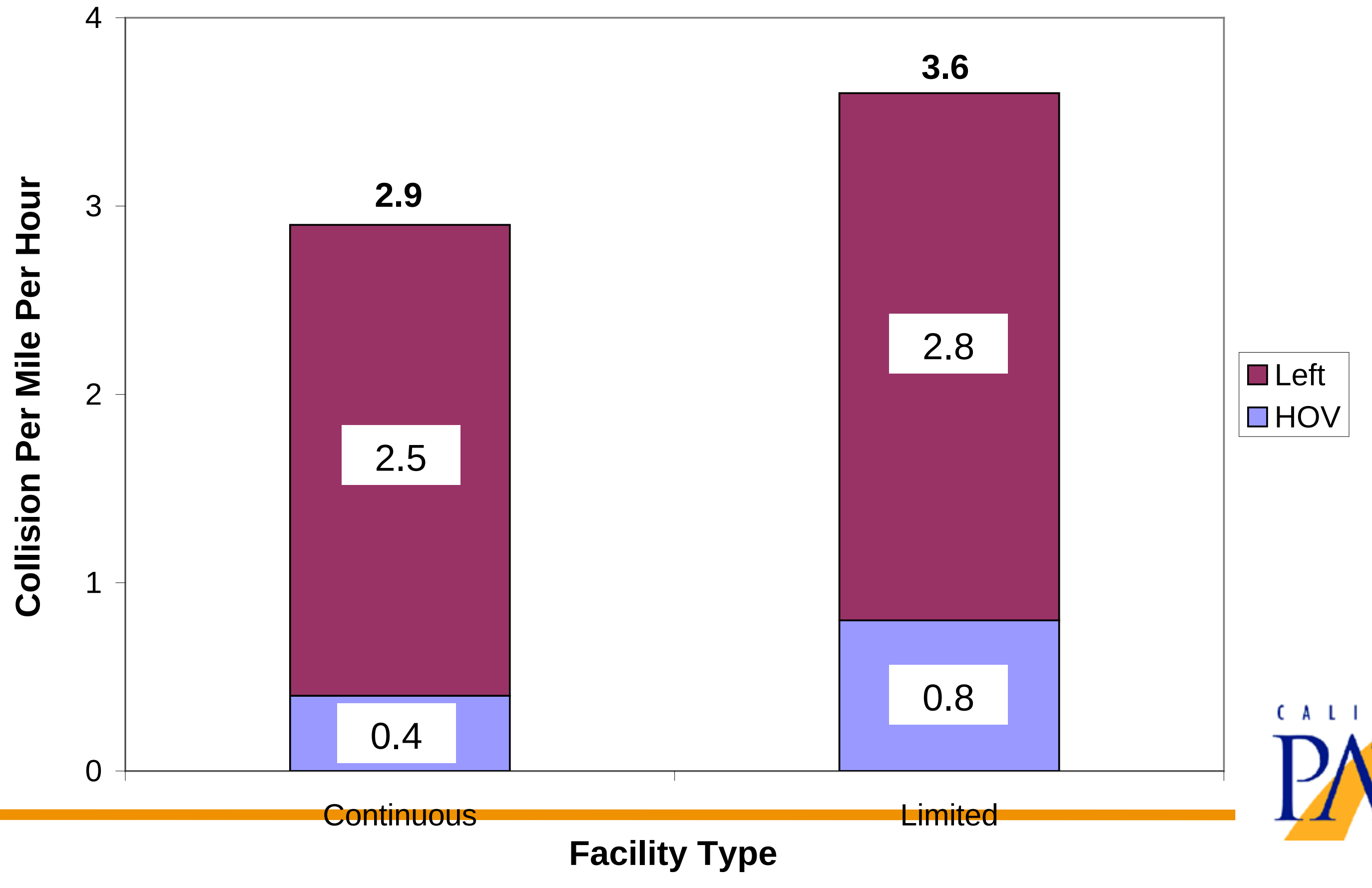
Statewide Comparison (Collision / Mile / Hr)

More than 60% of California HOV facilities included in the study

- Collision data from 1999 to 2003 were used
- During peak-hours (5-9 AM & 3-7 PM)



Detailed Comparison (Site Selection)

60% of HOV Facilities in California

- Sample Group (Statewide Comparison)
  - Constructed before 1999
  - more than 60% of HOV facilities in CA

14 Study Routes

- Suggested by Caltrans advisory panel and district engineers
- Considered to be comparable

8 Study Routes

- Working Loop Detector
- Construction Activity

8 Study Routes

- Check Comparability
  - **Regional Difference**
  - **Violation Rate**
  - **Speed Differential**
  - **Congestion Level**

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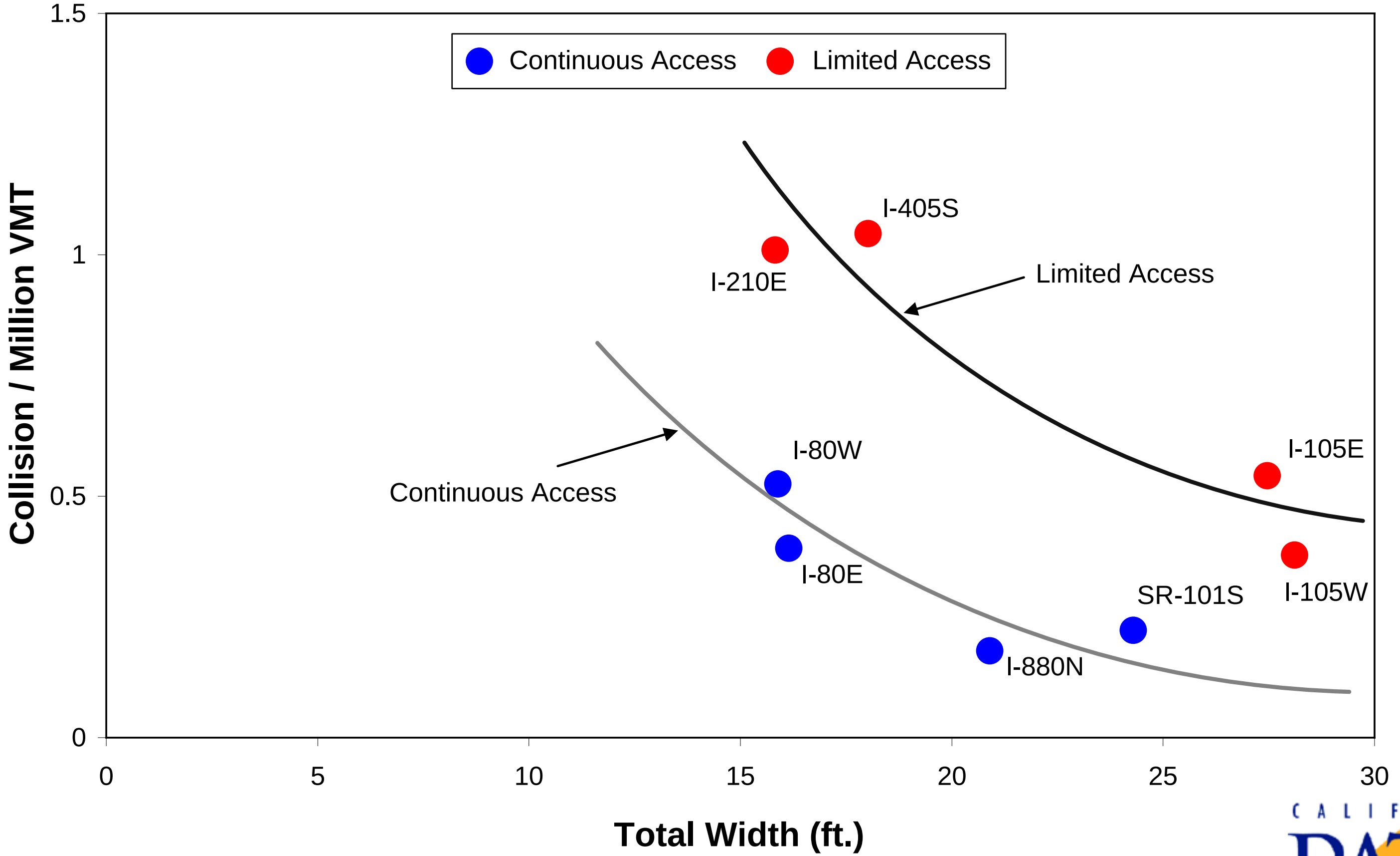
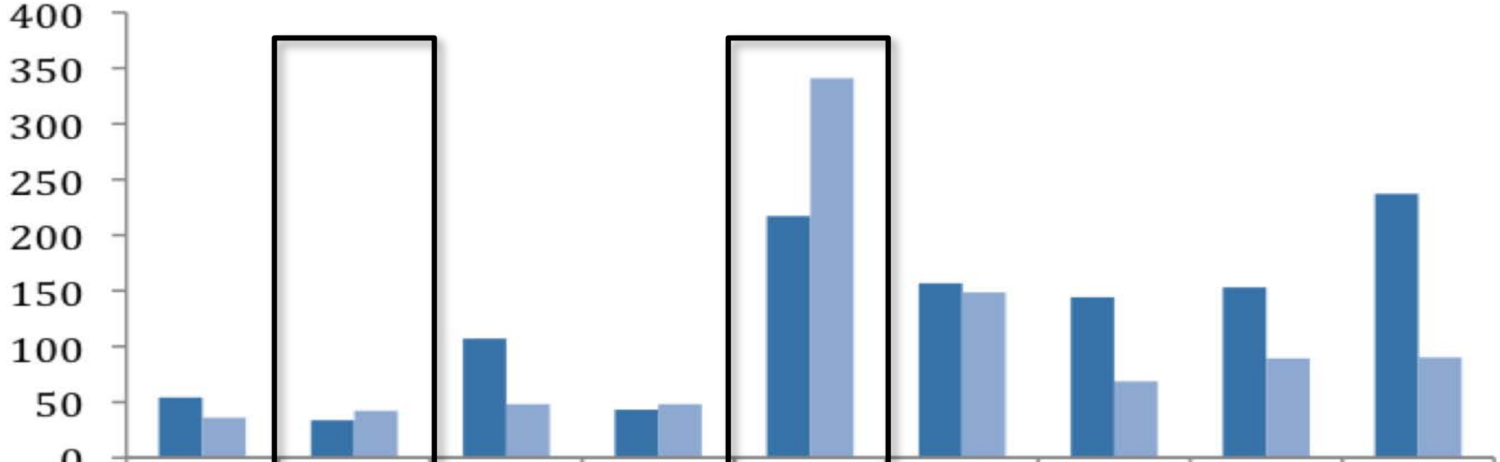
Geometric Factor (Total Width)

Total Width = Buffer (only for limited access) + HOV lane + Shoulder



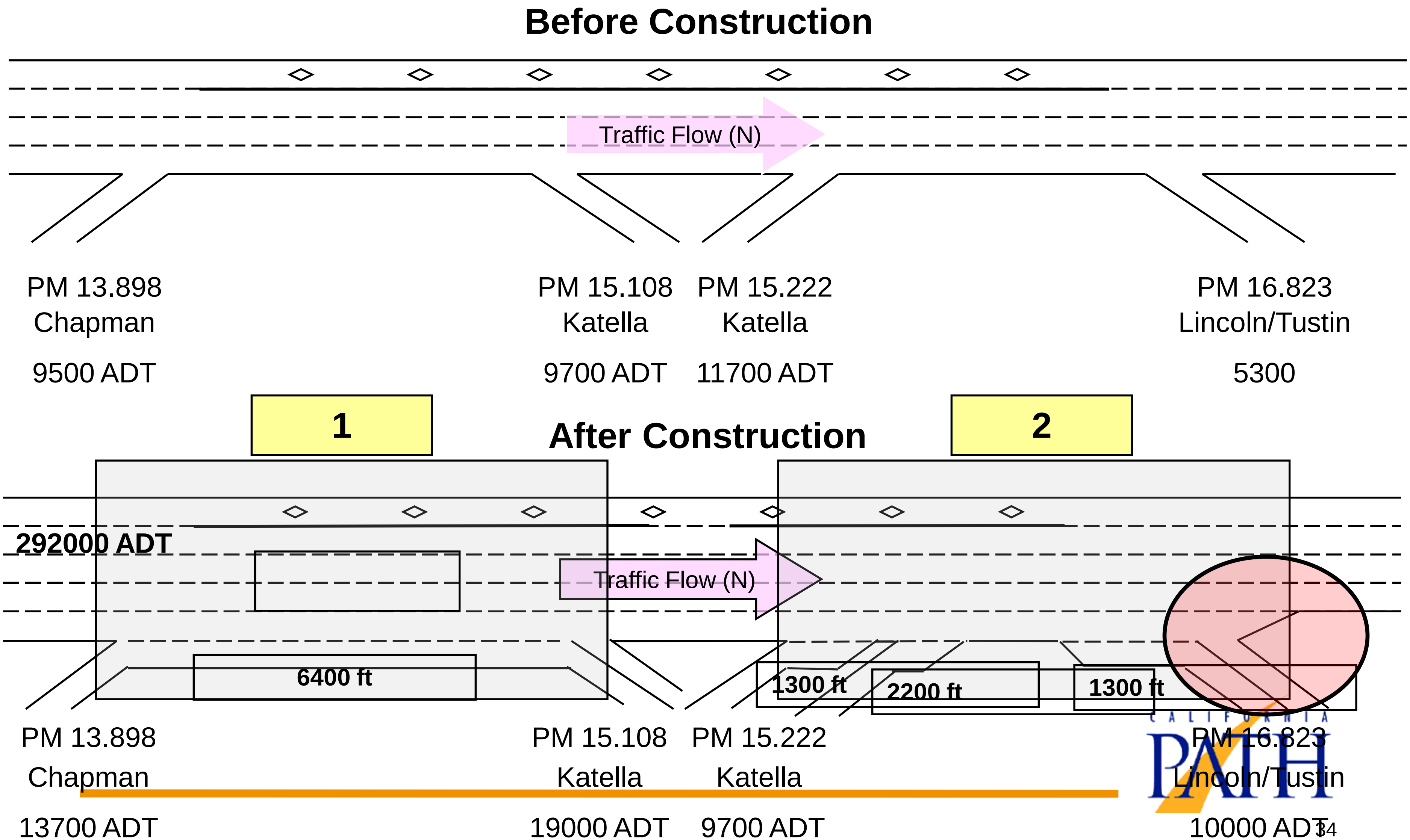
Before-After Collision Analysis
Auxiliary Lane Projects



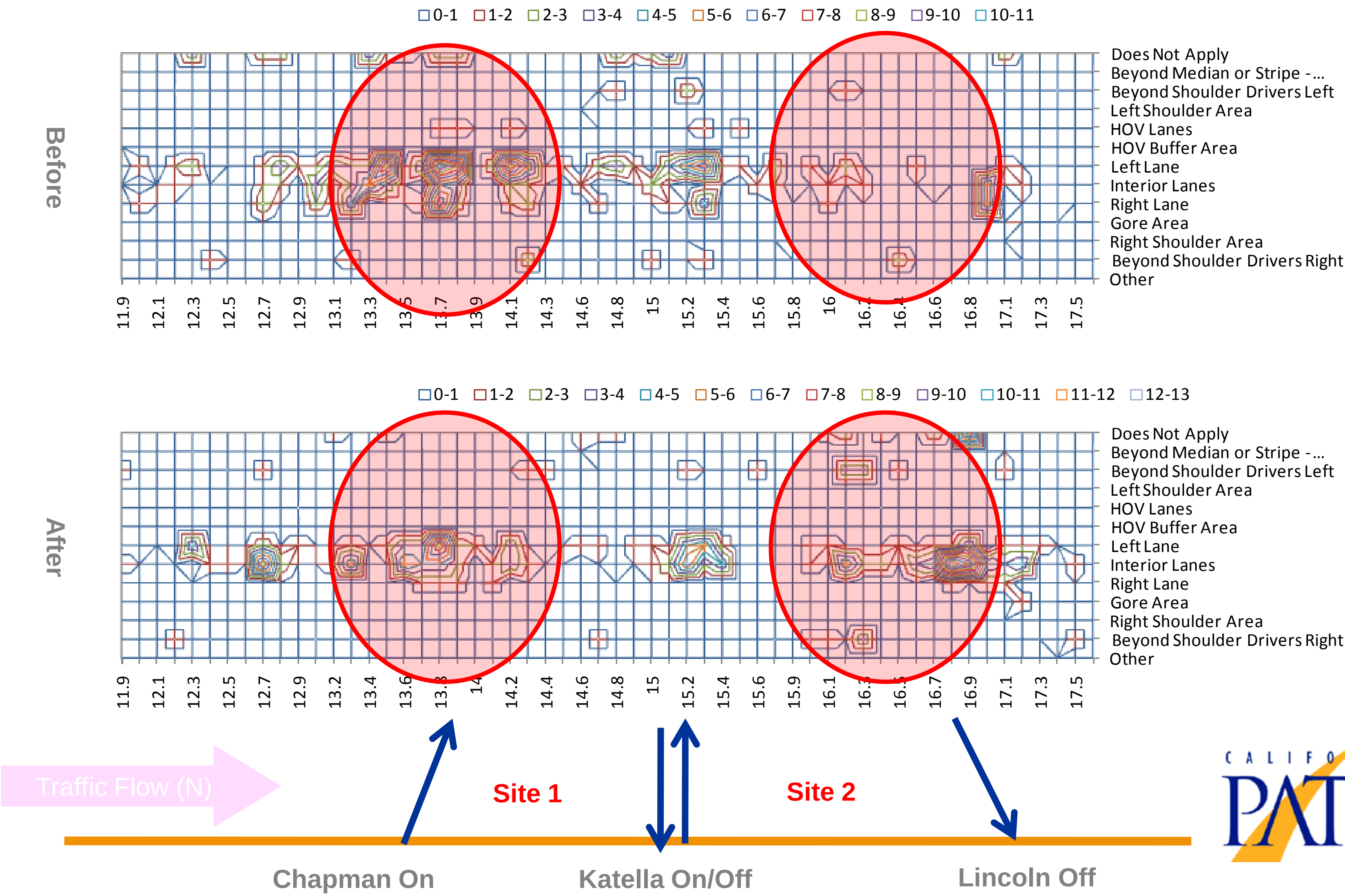
	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7	Site 8	Site 9
Before	54.2	33.7	107.1	43.1	217.2	156.7	144.3	153.1	237.1
After	36.1	42.1	48.1	48.1	341.0	148.6	68.7	89.4	90.2

- **A lane-drop (escape hatch) was formulated at site 2, contributing to the increase in collision rate.**
- **Site 5 has a short weaving section, suffering from heavy congestion due to high ramp flows.**
- **When these locations (sites 2 and 5) were excluded,, on average collision rates decreased by 31 percent (VMT-weighted)**

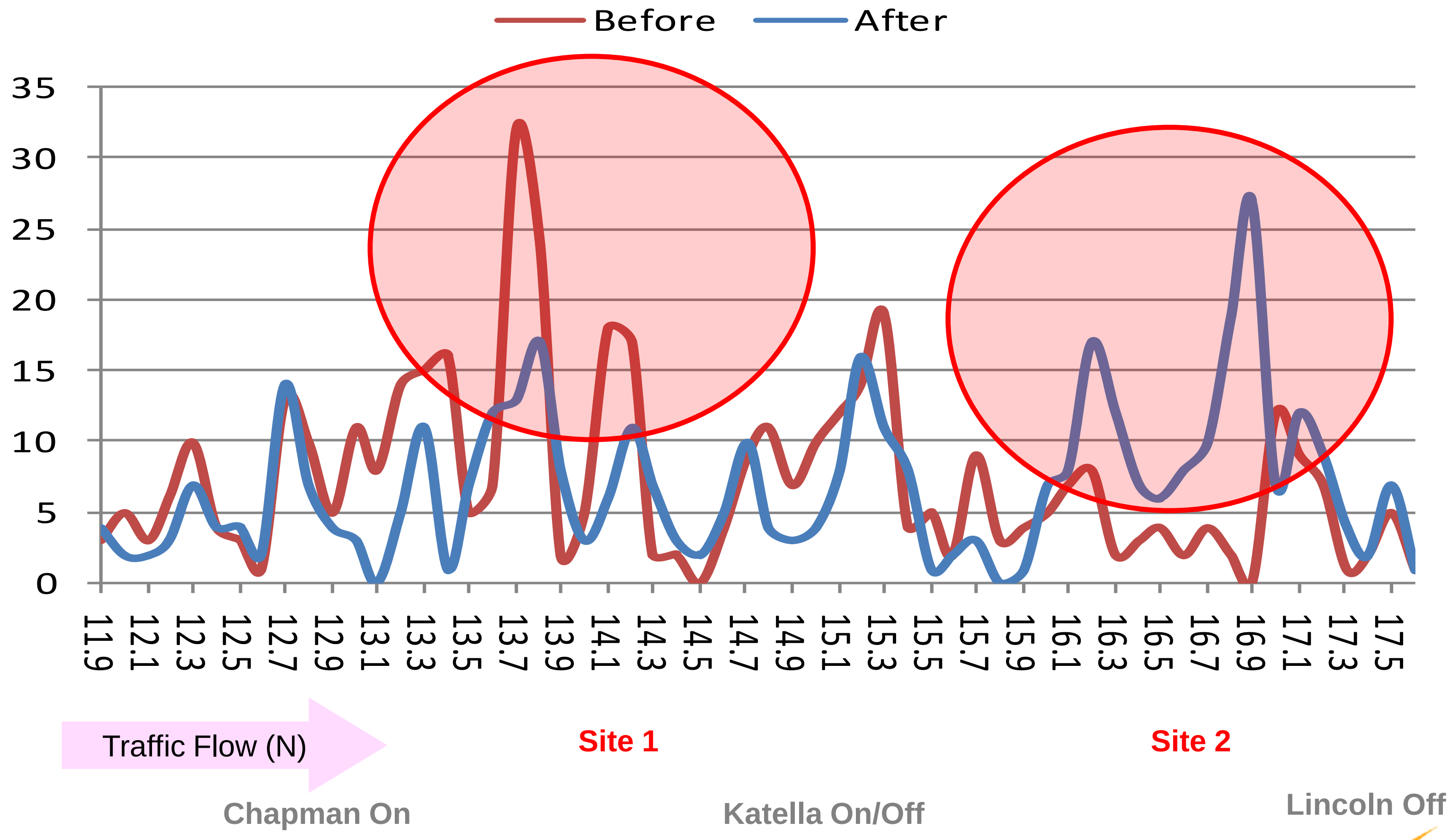
Construction of Auxiliary Lane: SR-55N



Before-After Collision Contour Map



SR-55N: Before-After Collision Profile



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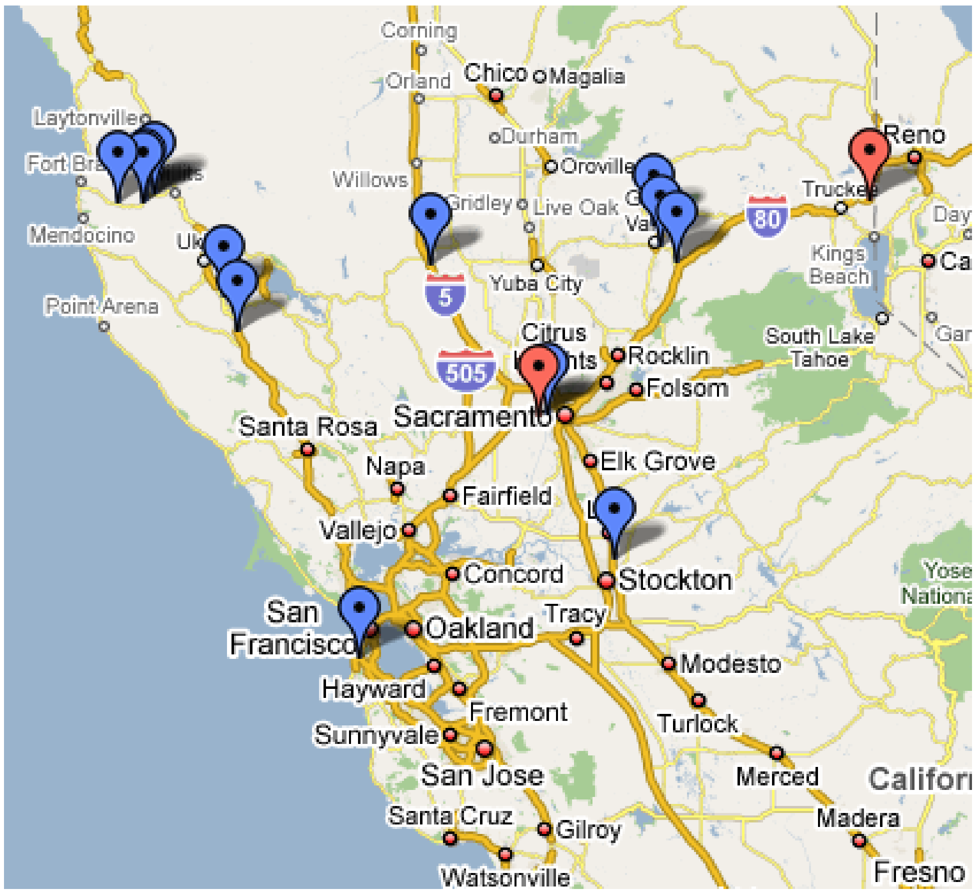
Before-After Analysis of Pavement Projects

Twenty-one sites of pavement improvement projects



OGAC	13
GP	4
R-OGAC	4
TOTAL	21

37

Statistical test result
using only the info. of treatment site

1. Based on Ratio Test of Before-After Numbers

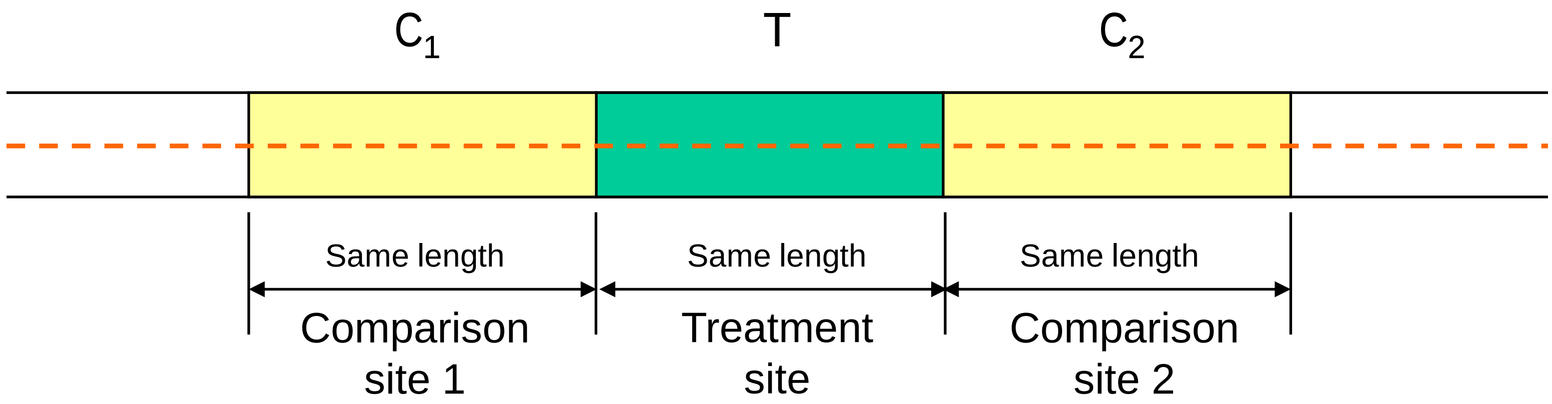
Ratio = θ = π/λ : ratio < 1 means collision is decreased

		OGAC (13)	GP (4)	R-OGAC (4)
Ratio (θ = π/λ)	θ	0.71	0.78	1.09
	STDV(θ)	0.13	0.11	0.37
	Confidence interval	(0.46,0.96)	(0.57, 1.00)	(0.35,1.82)
	Statistical significance	Decreased	Decreased	Not significant

Confidence level : 95%

38

Before-After study using comparison groups



Assumption a. The factors that affect safety have changed from the ‘before’ to the ‘after’ period in the same manner on both the treatment and the comparison group

Assumption b. This change in the factors influences the safety of the treatment and the comparison group in the same way

Statistical test result
by adjusting for comparison group changes

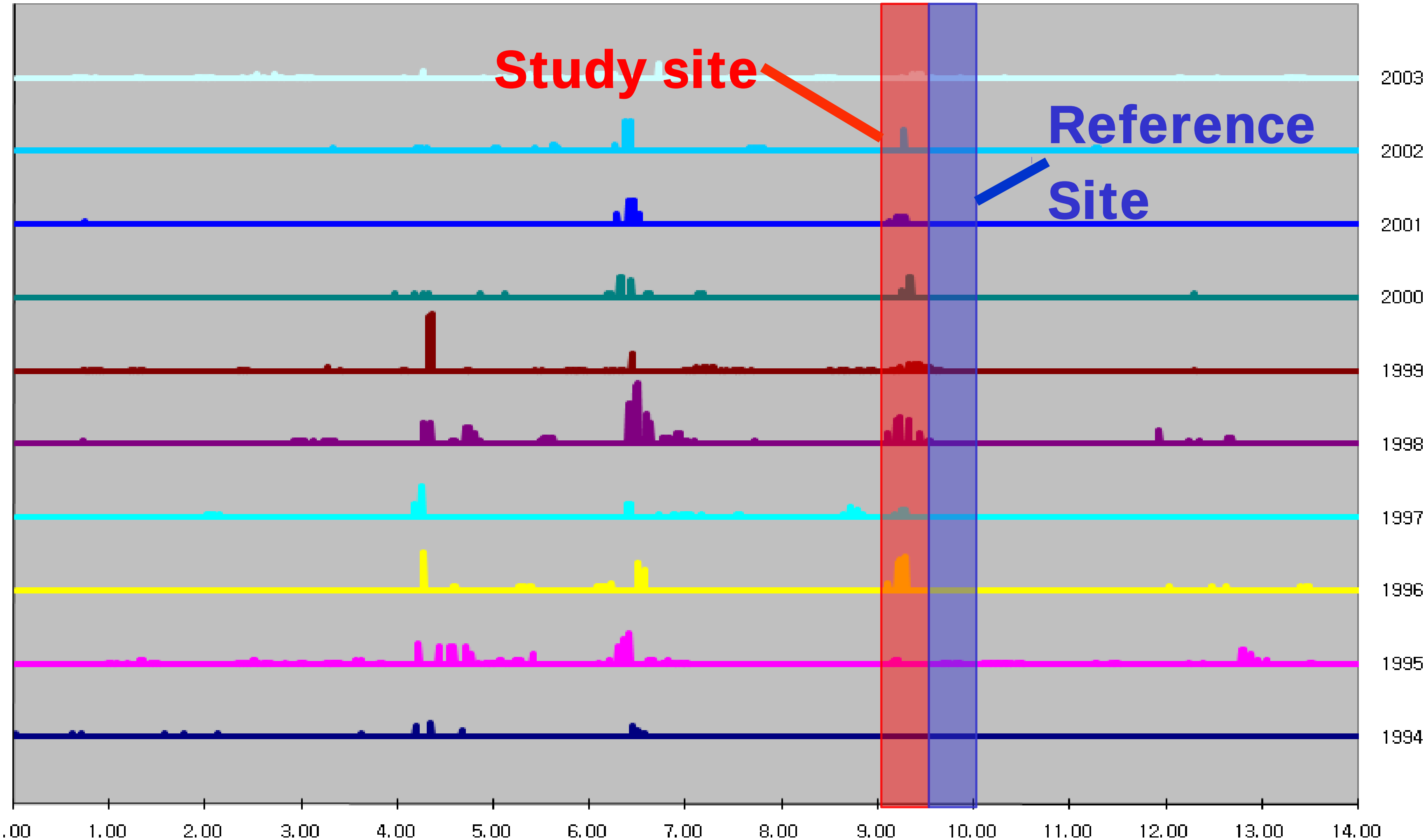
1. Based on Ratio Test of Before-After Numbers

Ratio = $\theta = \pi/\lambda$: ratio < 1 means collision is decreased

		OGAC (13)	GP (4)	R-OGAC (4)
Ratio ($\theta = \pi/\lambda$)	θ	0.59	0.50	1.07
	STDV(θ)	0.16	0.19	0.49
	Confidence interval	(0.27,0.90)	(0.12,0.88)	(0.10, 2.05)
	Statistical significance	Decreased	Decreased	Not significant

Confidence level : 95%

Wet Weather Collisions Causation Analysis - Comparison with Reference Site -



Reference Sites Analysis

			Study Site			Reference Site		
Route	Site ID	Distance	Start AbsPM	End AbsPM	Wet-Acc/mile/Yr	Start AbsPM	End AbsPM	Wet-Acc/mile/Yr
24E	1	0.4	6.3	6.7	28.3	5.7	6.1	1.5
	2	0.4	9.1	9.5	16.3	9.5	9.9	2.1
24W	3	0.4	4.1	4.5	40.5	3.6	4.0	1.6
580E	4	1.6	38.5	40.1	6.6	40.1	41.7	0.7
580W	5	0.7	44.5	45.2	8.4	43.8	44.5	2.1
	6	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	7	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
880N	8	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	9	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
880S	10	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	11	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	12	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
	13	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
680N	14	0.35	37.05	37.4	9.7	37.4	37.8	3.1
680S	15	0.25	35.45	35.7	18.8	35.2	35.45	0.6
	16	0.4	26.8	27.2	8.3	26.4	26.8	1.9
80W	17	0.4	30.5	30.9	14.4	30.1	30.5	4.6
	18	0.6	31.8	32.4	10.0	31.2	31.8	2.3
	19	0.9	33.4	34.3	11.2	34.3	35.2	4.3
280S	20	0.5	55.9	56.4	11.8	56.4	56.9	2.2

Average wet-collision rate

Study sites = 11.6 collisions/mile/yr

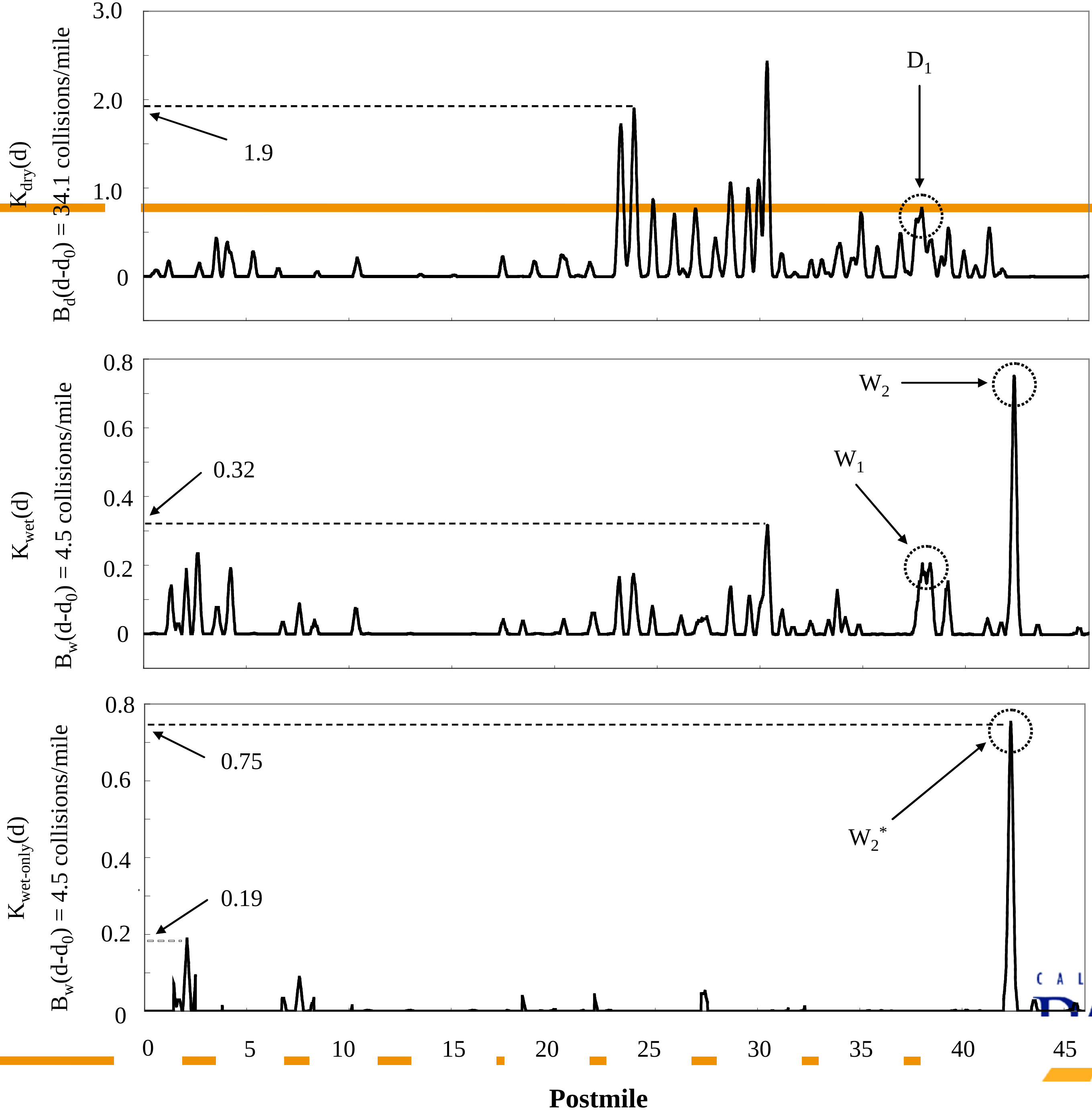
Reference sites = 2.9 collisions/mile/yr

PATH

DRY

WET

WET ONLY



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Safety Countermeasures & Solutions

- **TO 5210-6210**
  - **Red Light Running Avoidance**

- **TO 5212-6212**
  - **Automated Speed Enforcement**

- **TO 5216-6216**
  - **Expedited Crash Investigation**

Red-Light Running Study Objective

Traffic Signals

Improve efficiency

- Prevent gridlock
- Provide opportunity for minor streets

Improve safety

- Manage conflicting traffic streams

Design Constraints

Signal timing design tools

Objective: Develop a traffic signal design tool to reduce RLR while maintaining intersection efficiency.

Yellow Arrival and RLR

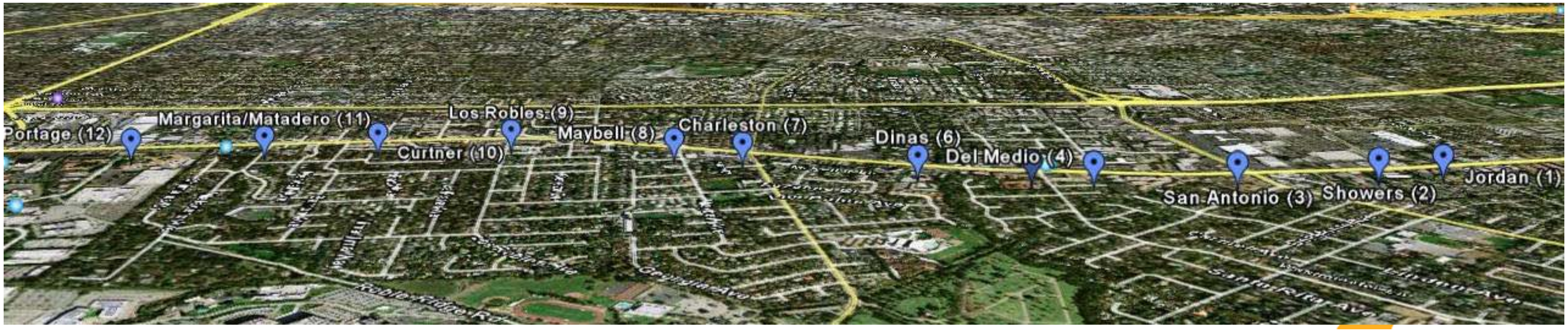
- **The statistical analysis found amber arrival flow (flow during yellow interval over the advance loops) to have the best match to the requirements:**

Statistically significant	Substantial impact on RLR	Controllable
Best p-value (p<.000, 5%) (t-statistic >150)	A change from average to maximum results in a 12%-32% increase in RLR probability	It may be possible to control yellow arrival by changing signal offsets

Research Methodology and Preparation for Field Testing

- Identify factors contributing to RLR
- Study mechanism of identified factors
- Develop optimization algorithm
- Develop optimization tool
- Evaluate algorithm performance
- Validate algorithm in simulated environment
- Perform field testing

12 intersection section on El Camino Real (between Jordan and Portage with master @ Dinahs)



ASE - Project Background

- Speed Enforcement, manual or automated, is known to be an effective countermeasure to have an impact on traffic speed as well as collision reduction.
- California Department of Transportation (Caltrans), like many other jurisdictions, is interested in exploring automated speed enforcement (ASE) as a countermeasure to improve highway safety.
- A project was initiated to explore the issues and hurdles in implementing ASE.
  - Legal
  - Institutional
  - Social
  - Technical

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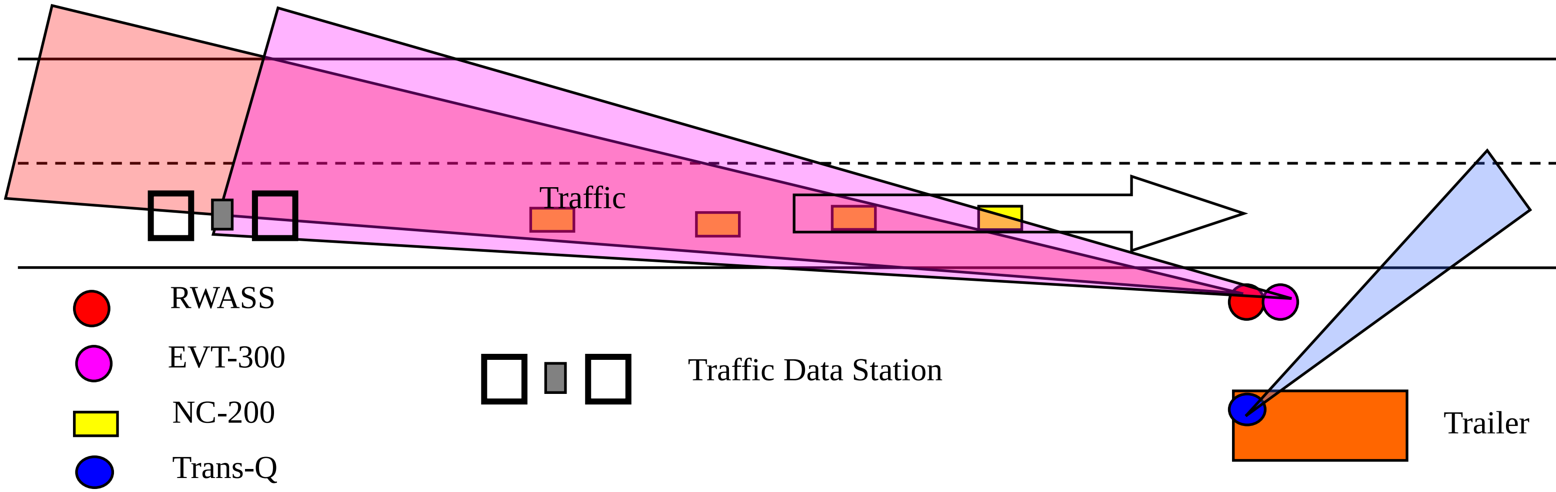
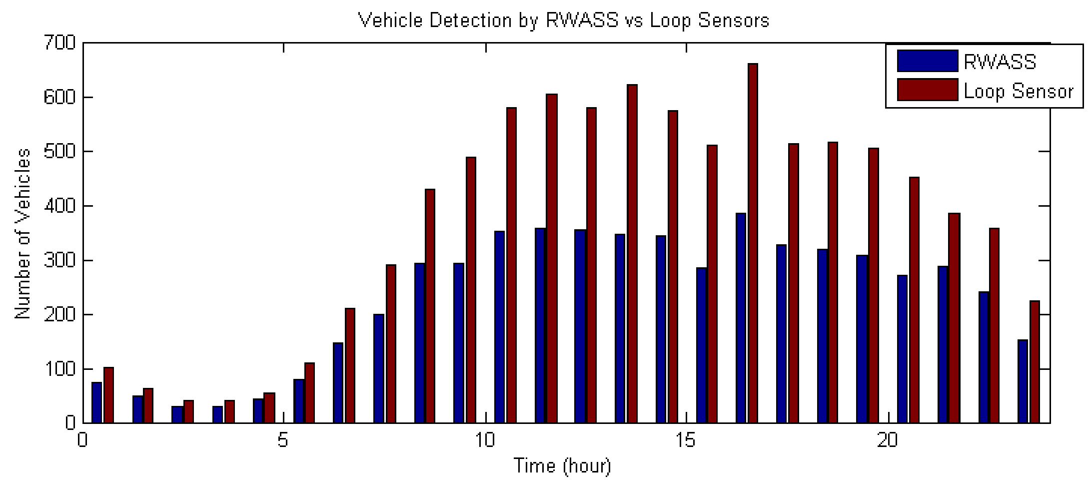
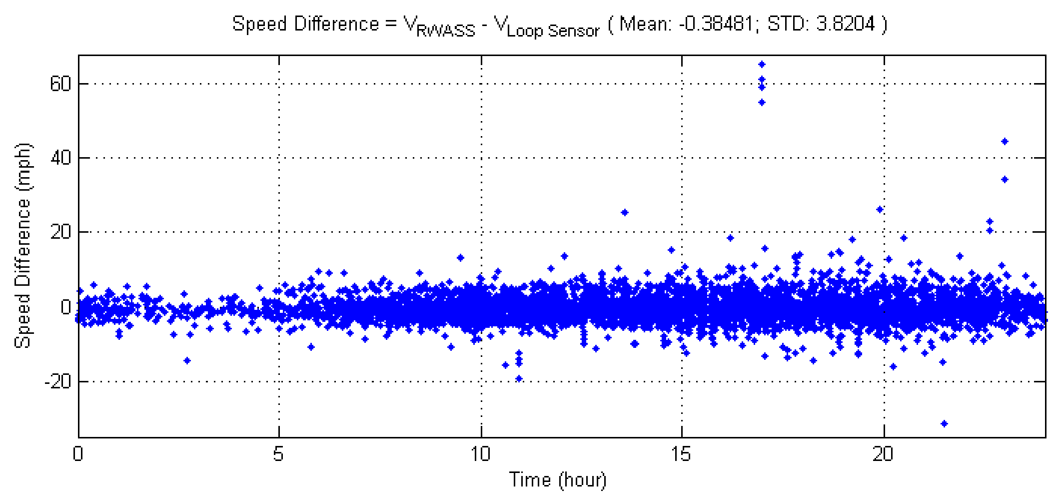
Field Testing of ASE Equipment
Experimental Setup



Data Comparison of ASE Equipment & Traffic Data Station

- **Calibrated Caltrans Traffic Data Station is used as the benchmark for comparison.**
- **RWASS tends to underestimates vehicle counts, due to occlusion caused by low-mounting position.**
- **Measured speed difference varies, significantly at times but rare.**





In-Vehicle Applications for Law Enforcement

- **Project Objectives**
  - **Evaluating ITS technologies to assist law-enforcement officers for safety and efficiency improvements**
  - **Exploring implementation strategies for GPS location data for incident reporting**
- **Project Partners**
  - **Caltrans, CHP**
  - **University of New Hampshire**
    - **CATLab, http://www.project54.unh.edu/**
  - **City of Carlsbad PD**
  - **UC Berkeley Police Department**

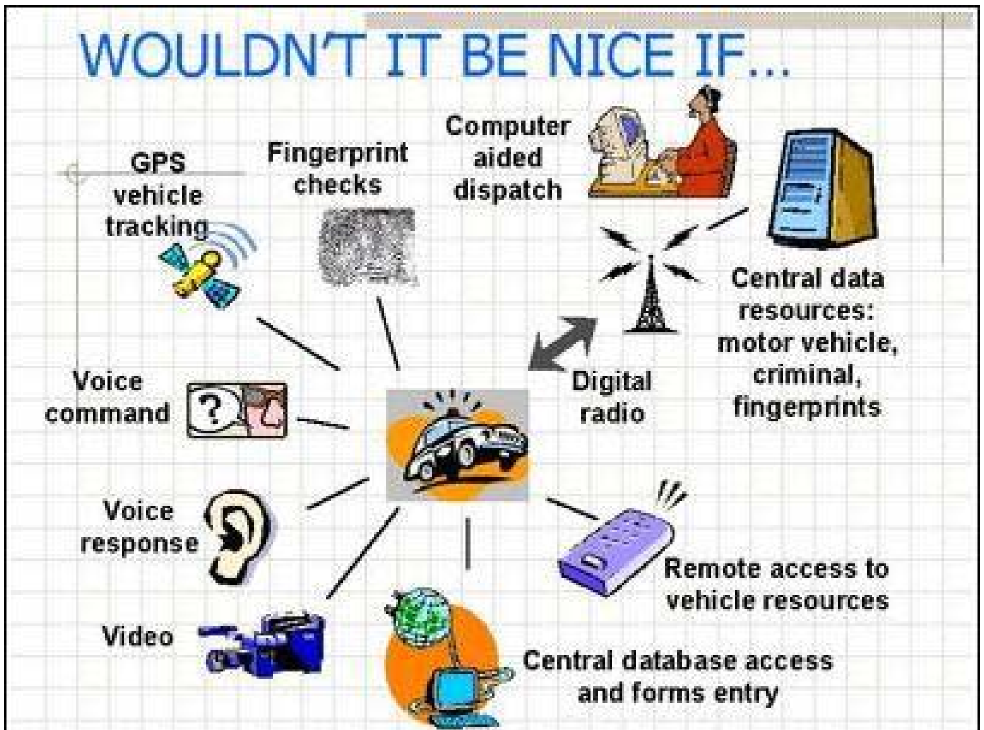
In-Vehicle Driver Assistance for Law Enforcement

- **Integrated Driver Assistance Systems for Police Cars**
  - Project 54 - Collaboration with University of New Hampshire & City of Carlsbad
  - Multiple User Interface – conventional switches, voice recognition, touch-screen
  - Mobile Office Environment

- **Integration of GPS/GIS in crash documentation**

State of the Art Technology – Project 54

Project54 gets its name from the forty year old TV show *Car 54, Where Are You?*



COMPLETELY INTEGRATED VOICE CONTROLLED POLICE CRUISER

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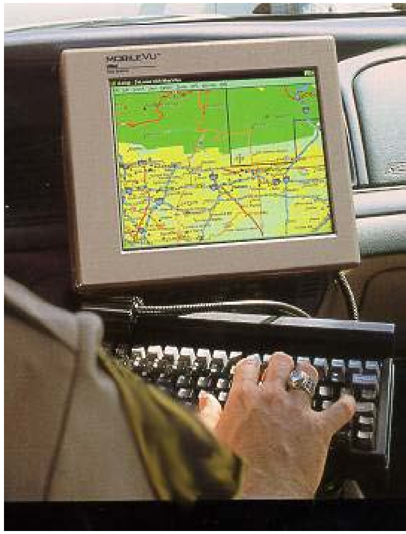
City of Carlsbad
- Public Safety Technology Project



- **Components & Functions –**
  - Cellular Wireless Communication Infrastructure,
  - Mapping-GIS,
  - Automatic Vehicle Locator,
  - Record Management,
  - Automated field reporting.

- **Reasons for selecting P-54**
  - Simple non-proprietary interfaces,
  - Compatibility with the widest possible range of equipment,
  - Single site license for $500 to cover an agency regardless of the number of vehicles,
  - Flexible and easy adaptation of desired components,
  - Specialized digital array microphone for voice recognition,
  - Short learning curve for new users,
  - Great cost-benefit returns for agencies.

*** Courtesy of Retired Captain Stockton, Carlsbad**

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Mobile Office = Enhanced Productivity

The system results in a mobile office capability for officers – office capability in the car.

- Registration/Stolen car inquiries,
- Driver license checks,
- Wanted persons,
- Email,
- Reports,
- Pictures,
- Crime analysis,
- Access all city and county justice systems.

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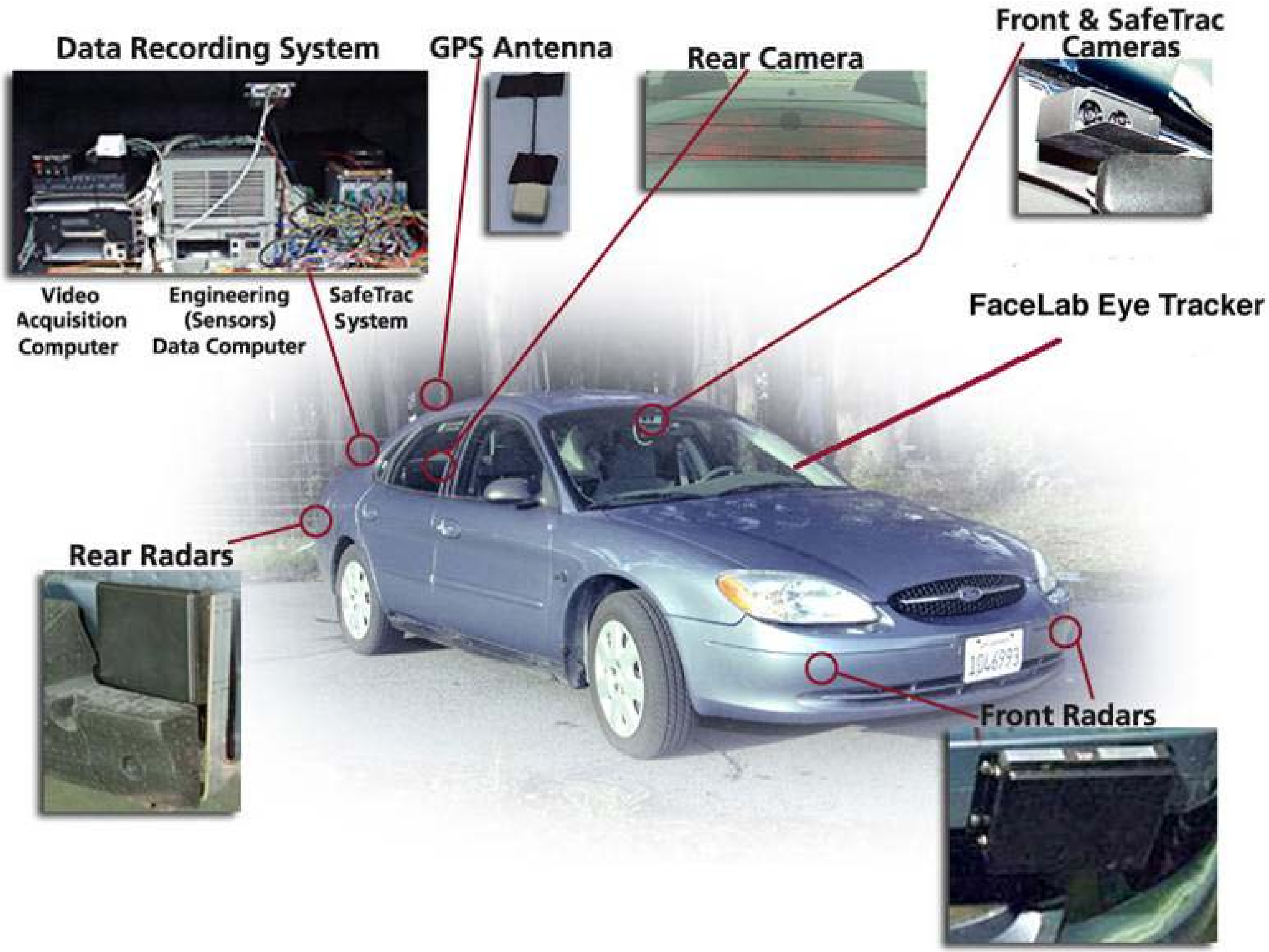
Driver Perception, Behavior, & Assistance

- **TO 5500-6500**
  - **The Naturalistic Driver Model: Development, Integration, and Verification of Lane Change Maneuver, Driver Emergency and Impairment Modules**
    - *Cognitive and perceptive processes in driver activities*
    - *Basis for evaluating benefits of driver support systems*
    - *Mechanism of distraction and impact on performance*
- **TO 5202-6202**
  - **CACC - Cooperative Adaptive Cruise Control (USDOT, Nissan, Caltrans)**
    - *Maintaining short following headway that is enabled through CACC*
    - *Driver acceptance in CACC driving environment*

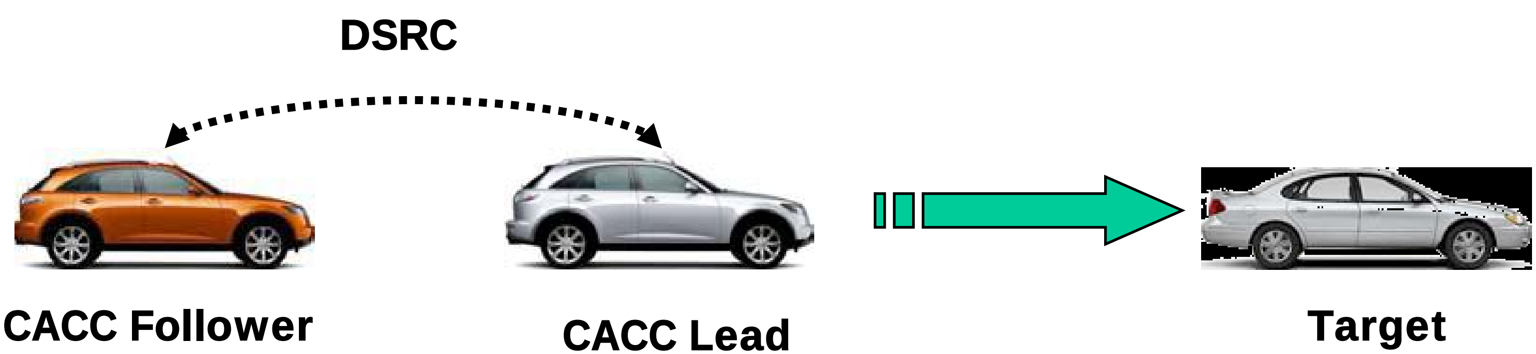
Driver Perception, Behavior, & Assistance

- **TO 5203**
  - **Optimizing Messages on Changeable Message Signs**
    - *Early vision versus cognitive process*
- **TO 5609-6609**
  - **On Board Monitoring for Commercial Vehicles (FMCSA)**
- **TO 6603**
  - **Methods to Address Headlight**
    - *Disability glare particularly a problem for older drivers*
    - *Glare Meter Tool to assess the level of glare from headlights of opposing vehicles*

PATH Instrumented Vehicle for Human Factor Studies



Cooperative Adaptive Cruise Control (CACC)



- **CACC extends from Adaptive Cruise Control (ACC) with the addition of V-V communication (DSRC)**
- **Potential increase in roadway efficiency without compromising safety**
- **Pilot Evaluation of driver experience**
  - **Two Nissan Infinity FX-45**
  - **ACC time gaps of 1.1 to 2.2 seconds**
  - **CACC time gaps of 0.6 to 1.1 seconds**

Onboard Monitoring System for Commercial Vehicle Safety (OBMS)

- **Develop safety monitoring platform for carriers and drivers**
- **Design a system**
  - **Design around stakeholder needs**
    - **Carriers, drivers, infrastructure owners/operators/enforcers**
  - **Leverage COTS components**
  - **Build and test a prototype**
  - **Document**
- **Prepare for Field Operational Test**
  - **Test the concept and its implementation**

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Specific Categories of Safety Problems

- TO 5200
  - Experimental Vehicle Platform for Pedestrian Detection
- TO 5204
  - Pedestrian/Bicycle Safety in a SMART Corridor
- TO 5202-6205
  - Work zone Safety Improvements through Enhanced Warning Signal Devices
- TO 5208
  - Investigation of Driver Behavior at Rail Crossing
- TO 5209-6209
  - Driver/Pedestrian at Marked and Unmarked Crosswalks
- TO 5211-6211
  - Estimating Pedestrian Exposure
- TO 6201
  - San Joaquin Rail Corridor Crossing Survey

Specific Categories of Safety Problems

- TO 6203
  - Bicycle Detection and Operational Concepts at Signalized Intersections
- TO 6204
  - Animal Warning Projects
- TO 6206
  - Vehicle Backing Accidents
- TO 6219
  - Ladder Style Crosswalks
- TO 6220
  - Driver Fatigue
- TO 6221
  - Causes of Pedestrian and Accident Traffic Fatalities
- TO 6222
  - Factors that Determine Bicycle and Pedestrian Collision Rates

Summary of Pedestrian Related Research

- **Technology Evaluation**
  - Experimental Vehicle Platform for Pedestrian Detection (TO 5200)
- **Detection and Signal Control**
  - Bicycle Detection and Operational Concepts at Signalized Intersections (TO6203)
- **Assessment of Pedestrian Safety**
  - Driver/Pedestrian at Marked and Unmarked Crosswalks (TO5209-6209)
  - Estimating Pedestrian Exposure (TO5211-6211)
  - Ladder Style Crosswalks (TO6219)
  - Causes and factors (TO6221 and TO6222)

Bicycle Detection and Operational Concepts at Signalized Intersections

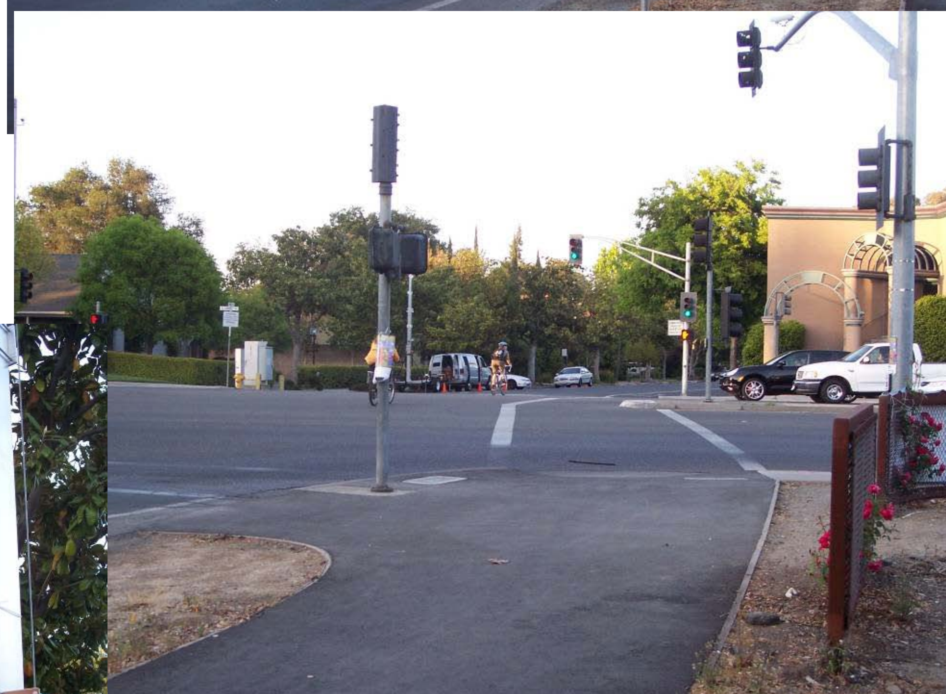
SIGNED INTO LAW - AB 1581 Traffic-actuated signals
October 2007, Effective January 2008

Summary: This bill would include as an official traffic control device *a traffic-actuated signal* that displays one or more of its indications in response to the presence of traffic detected …. Upon the first placement or replacement of a traffic-actuated signal, the signal would have to be installed and maintained, …, so as *to detect lawful bicycle or motorcycle traffic on the roadway*.

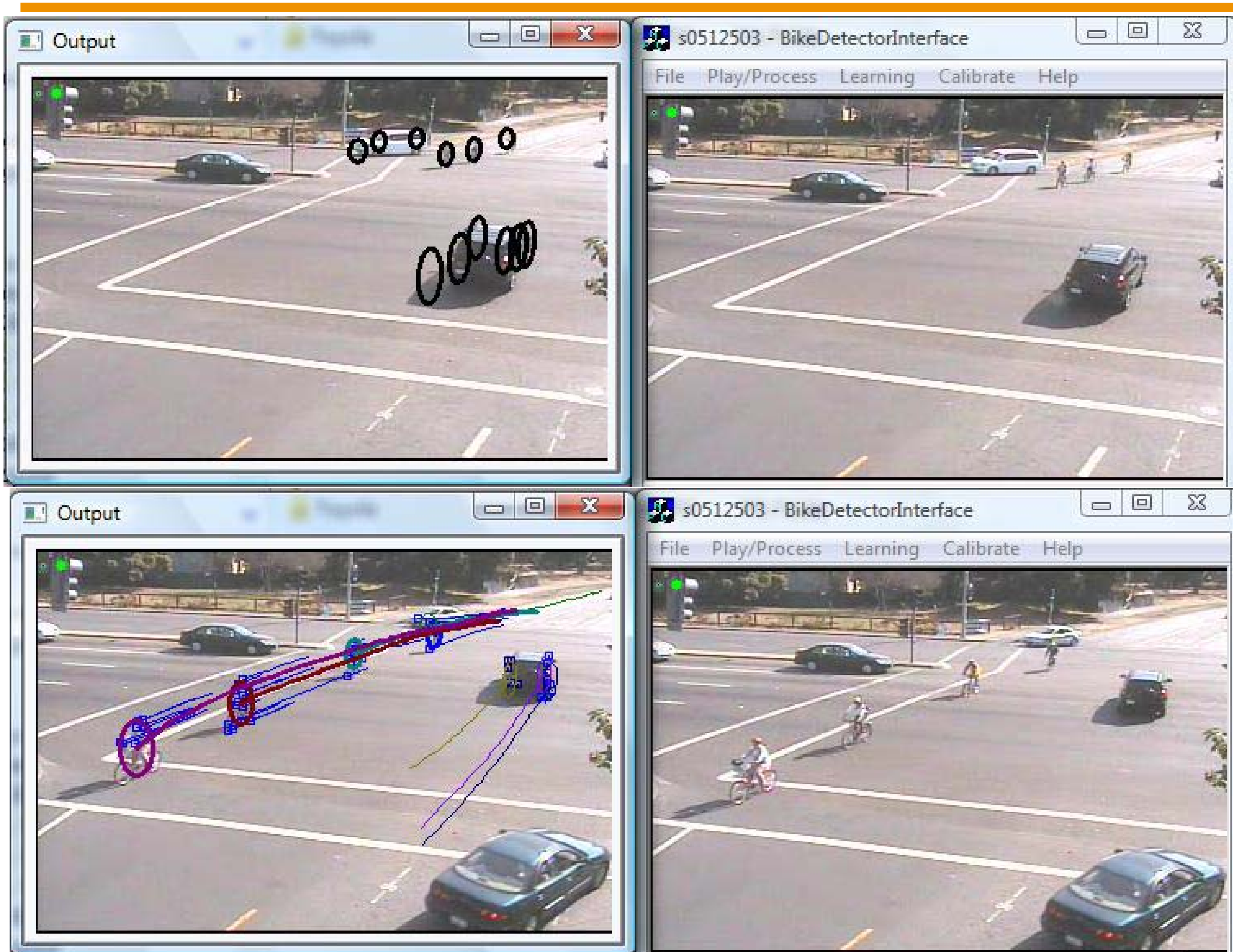
Caltrans Directive 09-06, Sept-10-2009

Provide Bicycle and Motorcycle Detection on all new and modified approaches to traffic-actuated signals in the state of California with guidance for minimal bicycle timing.

Video Observation Equipment at Park Blvd.

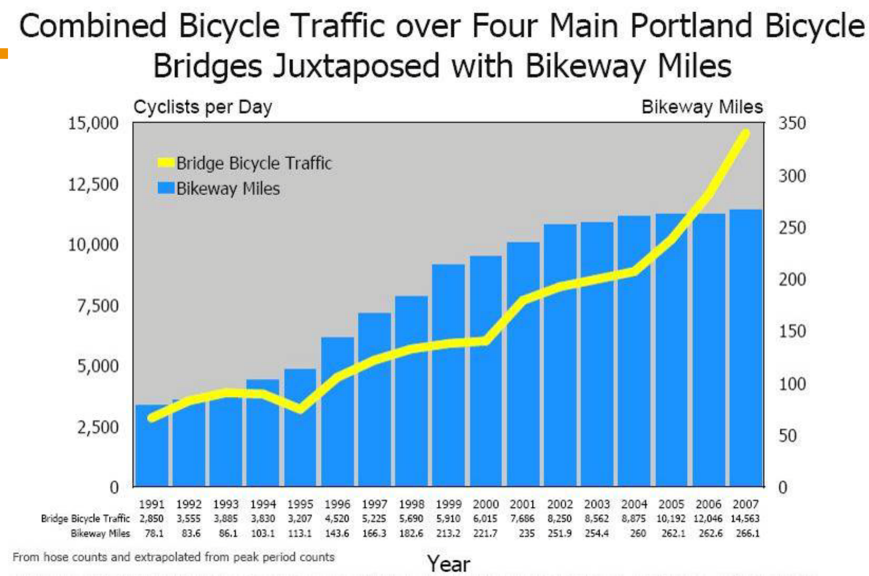


Video Data Imagery (Examples)



Why are Pedestrian Volumes Important?

- **Track pedestrian volume over time**
- **Quantify exposure to calculate pedestrian crash risk**
- **See where & when pedestrian activity occurs**



City of Portland, OR

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Quantify Pedestrian Exposure
- Manual and Automated Counting

Estimating Pedestrian Volumes from Statistical Models

- **Developed model from counts at 50 intersections in Alameda County**
- **Identified factors associated with higher vols.**
  - **Total population within 0.5 mi**
  - **Total employment within 0.25 mi**
  - **Number of commercial retail properties within 0.25 mi**
  - **Presence of regional rail station within 0.1 mi**

- **Created simple spreadsheet for applying model**

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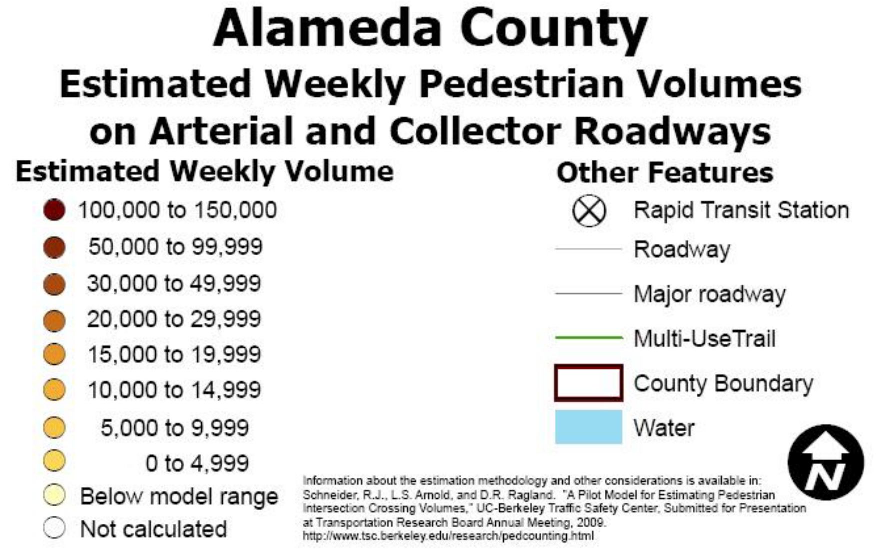
Pilot Model Formula

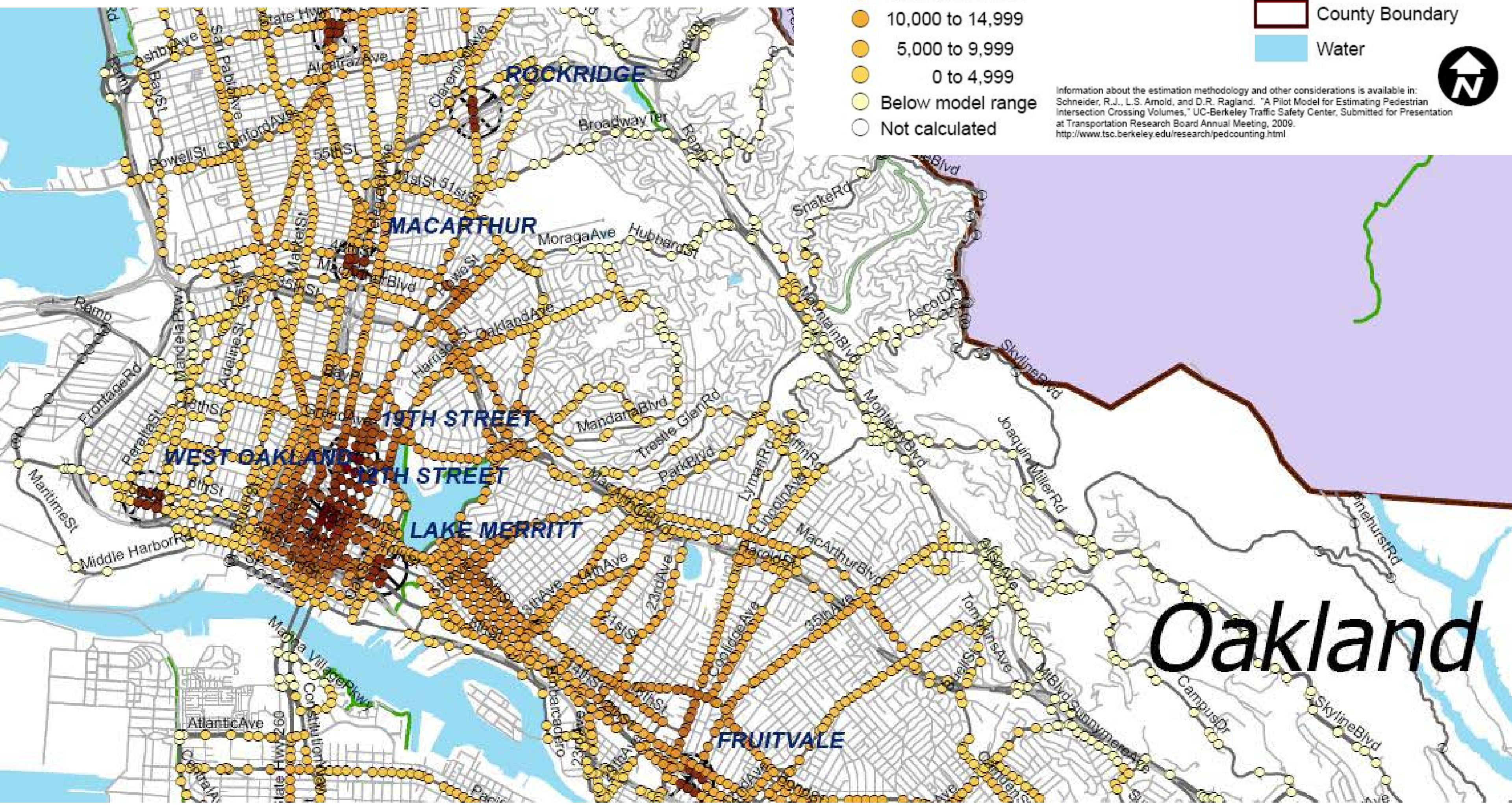
Estimated Weekly Pedestrian Crossings =

0.928 * Total population
within 0.5-miles of the intersection
\+ 2.19 * Total employment
within 0.25-miles of the intersection
\+ 98.4 * Number of commercial properties
within 0.25-miles of the intersection
\+ 54,600 * Number of regional transit stations within
0.10-miles of the intersection
\- 4910 (Constant)

Adjusted $R^2=0.897$
Independent variables significant at 95% confidence level

Pilot Pedestrian Volume Model Application





Which Intersection Features are Associated with Pedestrian Risk?

Pedestrian Crossings (+)

While intersections with more pedestrian crossings have more pedestrian crashes, there may be a "safety in numbers" effect (i.e., lower crash risk per crossing).

(Expected Effect: 100% more pedestrian crossings, 49% more crashes)*

Motor Vehicle Volume (+)

There may be a "danger in numbers" effect with mainline motor vehicle volume, but need to explore the influence of congestion and speed.

(Expected Effect: 100% more mainline AADT, >100% more crashes)*

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Which Intersection Features are Associated with Pedestrian Risk?

Number of Right-Turn-Only Lanes (+)

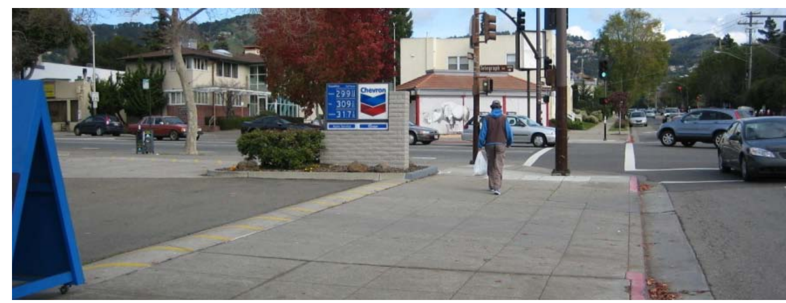
Intersections with more right-turn-only lanes may have longer crossing distances and more complex interactions between drivers and pedestrians.

(Expected Effect: 1 more right-turn-only lane, 53% more crashes)*

Number of Driveway Crossings (+)

Intersections with more non-residential driveway crossings within 50 ft. may have more conflict points; drivers may focus on entering or exiting motor vehicle lanes.

(Expected Effect: 1 more driveway crossing, 33% more crashes)*



Medians (-)

Mainline and cross-street legs with medians have a refuge that allows pedestrians to cross one direction of traffic at a time, which may make crossing safer.

(Expected Effect: Medians on mainline roadway crossings, 75% fewer crashes)*

Which Intersection Features are Associated with Pedestrian Risk?

Number of Commercial Properties (+)

Intersections with more commercial properties within 0.1 miles may have more drivers looking at signs and for parking; more pedestrians may cross between cars.

(Expected Effect: 100% more pedestrian crossings, 49% more crashes)*

Percentage of Residents Under 18 (+)

A greater percentage of young pedestrians within 0.25 miles may indicate that more of the people crossing are less experienced and have higher risk crossing busy streets.

(Expected Effect: 100% more mainline AADT, >100% more crashes)*

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Meeting Caltrans' Needs for Safety Research

Addressing Safety Research Needs in California

- **Caltrans Strategic Plans – meeting the needs and priorities in California**
- **SHSP – tackling a number of challenge areas**
- **Specific categories – significant target areas (run-off-the-road, intersection, pedestrian, etc.)**
- **Future Directions – identifying emerging trends and research questions**

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Priorities in Caltrans Strategic Plan
(Reference: DRI Annual Report 2008)

- **Strategic Research Selection Process**
  - Research Topics Derived from Customer Needs

- **Strategic Research Priorities**
  - SF4 - PROACTIVE SAFETY - What can Caltrans do to mitigate collisions? (i.e. Take on challenges before they become serious.)
  - *How do we collect and mine data to understand safety issues better?*
  - *Can we foresee safety problems and emerging trends better?*
  - *Are we adopting best available practices and provide suitable guidelines at the early stage?*

- **Leveraging National Resources (PFS, NCHRP, etc.)**
- **National Engagement (FHWA, RITA, etc.)**

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Research Activities and Corresponding Challenge Areas in Strategic Highway Safety Plan (SHSP)

Challenge Areas:

1. Reduce Impaired Driving-Related Fatalities
2. Reduce the Occurrence and Consequence of Leaving the Roadway and Head-On Collisions
3. Ensure Drivers are Properly Licensed
4. Increase Use of Safety Belts and Child Safety Seats
5. Improve Driver Decisions about Rights-of-way and Turning
6. Reduce Young Driver Fatalities
7. Improve Intersection and Interchange Safety for Roadway Users
8. Make Walking and Street Crossing Safe

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Past and Ongoing Research and Corresponding Challenge Areas in Strategic Highway Safety Plan (SHSP)

Challenge Areas

9. Improve Safety for Older Roadway Users
10. Reduce Speeding and Aggressive Driving
11. Improve Commercial Vehicle Safety
12. Improve Motorcycle Safety
13. Improve Bicycling Safety
14. Enhance Work Zone Safety
15. Improve Post Crash Survivability
16. Improve Safety Data Collection, Access and Analysis
17. (?) Reduce Driver Distraction

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Research Directions

- Looking Ahead -

Phenomenon of Improved Statistics in Recent Years

- **Safety is Improving. Why?**
  - 4E's: Education, Enforcement, Engineering, and Emergency Medical Services
  - Reduced level of driving?
  - Shift in patterns of driving?
  - Reduction in teenager drivers getting license at 16 (Washington Post, 1/29/2010)
  - Increased vehicular safety performance?

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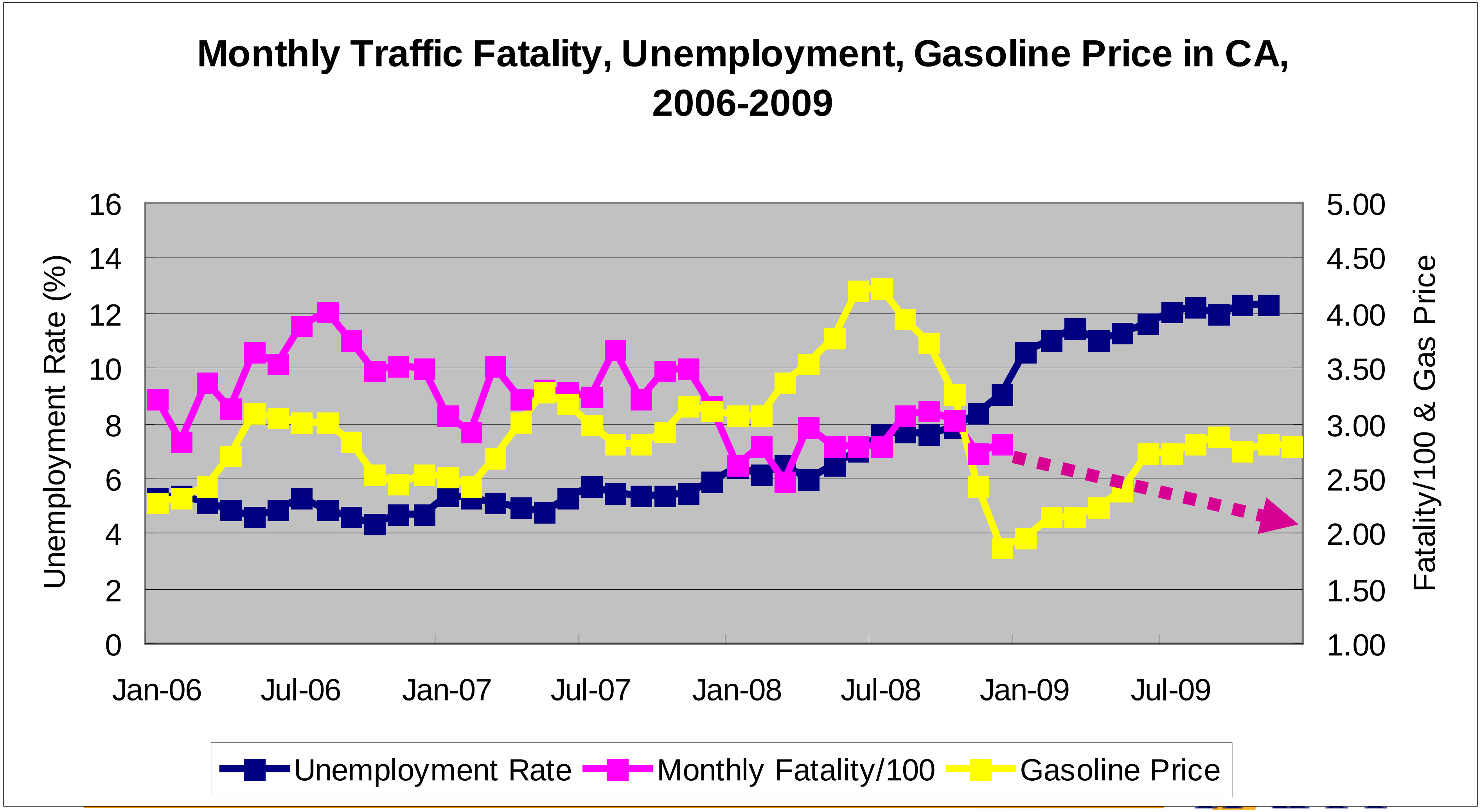
Will the trend continue?



Source: Bureau of Labor Statistics, DOE, and SWITRS

Complications in Going Forward

- **Correlation to Economic Activities and Gasoline Price**
  - **A silver lining in the midst of a economic crisis, but the trend may reverse.**

- **Postulation / Lessons Learned**
  - **A policy-based increase in (gasoline) taxes may have positive effects on traffic safety**
  - **A shift to other transportation modes (transit) is likely to lead to improvements in traffic safety**

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Directions for Safety Research - the Big Picture -

- **Promote Multi-Modal Transportation**
  - Public transit systems in general have a better level of safety performance than highway driving
  - A modal shift in transportation demands will bring about safety and operational benefits
- **Achieve Efficient and Smooth Highway Operations**
  - Inefficient operation potentially lead to more incidents
  - Less congestion and smooth traffic flows minimize risks of collisions
  - Traffic accidents result in deterioration of operation, thus creating negative feedback

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Prevalent Trends in Transportation & Safety Research Questions

- **Increased Use of Technologies on Infrastructure and in Vehicles**
  - **Increased data amount and availability**
  - *How can we utilize and analyze data to understand safety issues and evaluate effectiveness better?*
  - **Greater level of monitoring and control**
  - *How do we leverage technology developments to implement safety applications?*
  - **Higher level of interaction**
  - *How do we ensure positive feedback and increase driver awareness?*

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Prevalent Trends in Transportation & Safety Research Questions (continued)

- **Increased System Complexity and Sophistication**
  - **Multiple-dimensional requirements and demands, including safety concerns, operation efficiency, system reliability, environmental consciousness, etc.**
  - *Do we have sufficient tools and models to assess the impacts?*
  - *Can we provide up-to-date guidelines for decision makers and safety engineers?*

  - **New Operation Concepts**
  - *Do we know enough about the safety consequences of emerging developments, such as HOT/Managed Lanes and Active Traffic Management?*
  - *Do we have the up-to-date tool sets for practitioners?*

Prevalent Trends in Transportation & Safety Research Questions (continued)

- **Demographics (Aging And Potentially More-Demanding Road Users)**
  - **Aging Drivers & Vulnerable Users**
  - ***How do we minimize the risks of older drivers and vulnerable road users?***

	2000				1990		% Increase 1990-2000	
Numbers	60 years old and over	65 years old and over	Percent 60+	Percent 65+	60 years old and over	65 years old and over	60 years old and over	65 years old and over
US Total	45,797,200	34,991,753	16.30%	12.40%	41,857,998	31,241,831	9.40%	12.00%
California	4,742,499	3,595,658	14.00%	10.60%	4,234,871	3,135,552	12.00%	14.70%

Source: Census Bureau

  - **Increased Contents of Information and Level of Interaction**
  - ***How do we manage information flow (in the context of traffic operations) and ensure positive feedback?***

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California Partners for Advanced Transit and Highways

PATH wins Annual ITS Best of ITS Research Award

Pictured From Left to Right:
Bob Franklin, Director, BART District 3
Randell H. Iwasaki, Deputy Director, Caltrans
Susan Shaheen, Program Leader, California PATH

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Strengths of PATH

- **Vision**
  - We have been a pioneer in leading innovative and advanced research.
- **Heritage**
  - We have a strong reputation nationally and internationally for carrying out applied research.
- **Capabilities**
  - We have a team of capable researchers and engineers that are talented in diversified fields of expertise.
- **Partnership**
  - We have a network of academic and industrial partners that can form strong teams to deliver fruitful outcome.

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Thank You!

Questions?