Program on Advanced Technology for the Highway
(1986 – 1991)

Partners for Advanced Transit and Highways
(1992 – 2010)

Partners for Advanced Transportation technology
(2011 - )
PATH Creation

• Caltrans’ 1985 study of future needs – cannot build our way out of congestion, but need technology
• 1986 Caltrans/Berkeley conference on future use of information technology for transportation operations – agreement with U.C. Berkeley Institute of Transportation Studies to create PATH
• First research program in U.S. on “intelligent vehicle-highway systems” – later broadened to “intelligent transportation systems”
Institute of Transportation Studies

• Created in 1948 by California Legislature, to lead research on transportation to support the state’s post-war growth

• PATH is the largest research program in the Institute. The others are on:
  – Transportation Sustainability
  – Transportation Safety
  – Aviation Operations Research
  – Future Urban Transportation Systems
  – Economic Competitiveness in Transportation
  – Pavement
PATH Goals

Developing Technologies to Help Solve (California’s) Main Transportation Problems

• Congestion/Mobility/Productivity of System
• Safety

With Ancillary Benefits in:

• Air Quality/Environment
• Energy Consumption
• Cost Effectiveness
• Regional/Statewide Economic Health
PATH’s California Objectives

• Conduct ITS research for Caltrans’ Division of Research and Innovation and System Information (DRISI) and others
  – technology and policy research
  – proof-of-concept testing
  – design and evaluation of operational tests

• Bring best available minds to bear on solving California’s surface transportation problems

• Train the next generation of transportation professionals
PATH Program Management

• Combine faculty, graduate student and professional research staff activities so each does what it does best
• Collaborate closely with Caltrans to meet specific state needs for ITS research, development, testing and demonstrations
• Work directly on some U.S. DOT projects, and through Caltrans or prime contractors on other projects
• Private and international sponsorship of some projects, partnerships on other projects
PATH Leadership Team

Directors

- Tom West
- Trevor Darrell

Traffic Management

- Alex Skabardonis

Transportation Safety

- Ching-Yao Chan

Mobility Systems

- Steven Shladover

New Initiatives

- Wei-Bin Zhang

System Development

- Joe Butler
PATH Capabilities

- Multi-disciplinary R, D & D projects
  - Civil, traffic, transportation engr.
  - Mechanical, electrical, industrial engr.
  - Computer science, software engr.
  - Human factors
  - Benefit/cost evaluation

- Large-scale experimental projects requiring continuous staff effort, including remote sites

- Development, prototyping and testing of infrastructure, vehicle and communication systems
Experimental Infrastructure

• Shop and laboratory space for work on both light and heavy duty vehicles
• Robert E. Parsons Traffic and Transportation Laboratory
• Wireless communications laboratory
• Experimental intersection
• Short test track

• Light and heavy duty test vehicles
Instrumented Intersection and Short Test Track

- Video image processor detector systems
- Radar pedestrian detector
- Sensys wireless detectors
- Wavetronix radar
- MS-Sedco InterSector radar for bike detection
- IR beam detectors
- Conventional and Type D inductive loops
- 3M Canoga micro-loops
- Savari and Arada DSRC RSEs
- SMS radar coverage of all approaches
Shop Space for Vehicle Development
Experimental Vehicles
Vehicle Control and Automated Driving Research at PATH

• Strong emphasis for 20 years → 600 labor years of PATH effort

• Approached from perspectives of vehicle dynamics and control and human factors
  – Deep understanding of mechanical dynamics of vehicles
  – Designing for both high positioning accuracy and smooth ride quality
  – Driver and passenger acceptance based on ride quality and user interfaces

• Experimental verification on full-scale vehicles (20+ passenger cars, 7 heavy trucks, 5 transit buses, 1 snowblower)
Project Sponsorships

• Primarily state and federal DOTs
• Automotive Industry Sponsors
  – Nissan Technical Center North America
  – VW/Audi Electronics Research Lab
  – Toyota InfoTechnology Center
  – BMW of North America
  – Renault
  – General Motors
  – Ford
  – Mercedes Benz Research & Development North America
  – Honda R&D North America
  – Visteon
Automation is a Tool for Solving Transportation Problems

• Alleviating congestion
  – Increase capacity of roadway infrastructure
  – Improve traffic flow dynamics

• Improving safety
  – Reduce and mitigate crashes

• Reducing energy use and emissions
  – Aerodynamic “drafting”
  – Improve traffic flow dynamics

• Using V2V and I2V connectivity to gain these benefits
PATH Automation Milestones

- 1988 – Basic AHS concepts defined
- 1991 – Hierarchical information architecture
- 1992 – First automated vehicle experiments (4-car longitudinal control platoon, one car automated steering control) and first FHWA funding support
- 1993 – AHS Precursor System Analyses
- 1994-8 – National AHS Consortium (including Demo ’97)
- 1998 – Demo ’98, Netherlands
- 2000 – Demo 2000, Japan
- 2003 – Bus and truck automation demonstrated
- 2007-11 – Mobility Applications for VII project (FHWA)
- 2013 – New CA DMV and FHWA EARP projects
Consistent, Accurate Steering on Highway

- 3 cm lateral variations at every location at highway speeds
Vehicle Assist and Automation (VAA) – Automatic Steering Control of Buses

- **Objectives**
  - Implement VAA applications using two guidance technologies (magnetic & DGPS-based)
  - Address VAA deployment issues and assess benefits and costs in revenue-service operations

- **Team**
  - FTA, Caltrans, 2 transit operators, PATH, industrial contractors

- **Transit revenue service**
  - Lane Transit District (LTD) Franklin EmX BRT service (Eugene, OR):
    - A 2-mile route, with 3 intermediate stations, round trip
    - Public revenue service in 2014
Automatic Longitudinal (Platoon) Control

- Engines and brakes of conventionally powered vehicles can be controlled accurately enough for precision vehicle following in platoons (20 cm accuracy)
- Precise vehicle following can be done with smooth ride quality
- Vehicles can be driven in close-formation platoons (3 – 5 m gaps) without exposing occupants to exhaust gases or impeding cooling air to radiators
- Vehicles can merge into the middle of a passing platoon, using wireless coordination
Automated Platoon Longitudinal Control and Merging

1997

2000
PATH V2V Truck Platoons (2003, 2010)

2 trucks, 3 to 10 m gaps

3 trucks, 4 to 10 m gaps (6 m in video)
Current Automation Projects

• FHWA EARP – Partial Automation for Truck Platoon
  – With Volvo Trucks, Caltrans, LA Metro
  – Experimental implementation on new Volvo platform
    – cooperative ACC, testing driver acceptance and energy savings

• FHWA EARP – Using Cooperative Adaptive Cruise Control to Form High-Performance Vehicle Streams
  – With TU Delft as subcontractor
  – Simulations of high-level control strategies
  – Estimating traffic impacts of CACC

• California DMV automation regulations support
  – Technical advice to state developing regulations for testing and public operation of AVs