

**CCIT**

**California Center for Innovative Transportation**

**DEPLOYING MOBILITY SOLUTIONS**



**2005 ANNUAL REPORT**



California Center for Innovative Transportation  
University of California, Berkeley  
2105 Bancroft Way, Suite 300  
Berkeley, CA 94720-3830

Phone: 510-642-4522  
Fax: 510-642-0910

Email: [frontdesk@calccit.org](mailto:frontdesk@calccit.org)

[www.calCCIT.org](http://www.calCCIT.org)



## OUR MISSION

CCIT's primary mission is to facilitate and implement the operational deployment of transportation research and innovation. Working with researchers, practitioners, and industry partners, we focus on practical applications and short-term improvements to the safety, mobility and security of California's transportation system.

## WHAT WE DO

CCIT is a bridge between the academic world, transportation public agencies and the transportation industry. We focus on Intelligent Transportation Systems (ITS), leveraging our extensive experience, design and development capabilities for maximum effectiveness. What is truly unique about CCIT's activities is our dedication to transforming research results into deployable products and services that can directly benefit practitioners.

Located in downtown Berkeley, CCIT relies on a mix of engineers, post-doctoral researchers and UC Berkeley graduate students to deliver projects in four areas: Research Deployment, ITS Consulting and Implementation, Evaluation of Technology and overall Support to Research and Innovation. We also act as an industry forum and regularly invite practitioners and policy makers to meet with field experts, solution providers and researchers.

## PARTNERS AND CONNECTIONS

One of CCIT's strengths is to leverage its network of partners in academia, research, government and the private sector. Ever since the Center's inception, our facilities have been a focal point of exchange between our partners, fostering fruitful dialogs.

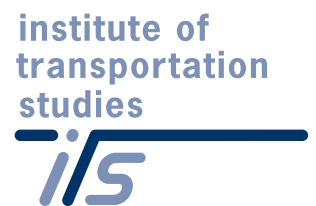
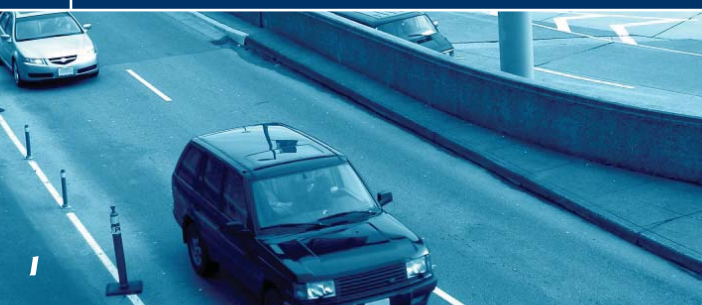
As part of the UC Berkeley Institute of Transportation Studies, CCIT collaborates with the Institute's other research centers. This allows the Center to work closely with leading academics in the field, especially those from the Partners for Advanced Transit and Highways (PATH) program. CCIT is also affiliated with the Institute of Transportation Studies at UC Irvine and UC Davis through, respectively, the Advanced Transportation Management and Information System (ATMIS) testbed and the new Mobility Center. Over the years, CCIT has collaborated with many programs in the University of California and California State University system.

Through its main sponsorship with the California Department of Transportation (Caltrans), CCIT works with Headquarters staff as well as local district practitioners. We also have strong ties with the principal Metropolitan Planning Organizations in California, such as the Metropolitan Transportation Commission of the San Francisco Bay Area (MTC), and the San Diego Association of Governments (SANDAG).

CCIT maintains regular contacts with a wealth of ITS companies, transportation consultants and professional organizations. CCIT was instrumental in bringing the 12th World Congress on Intelligent Transportation Systems to California, an unprecedented achievement for the state's ITS field.

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## DIRECTOR'S FOREWORD

The California Center for Innovative Transportation (CCIT) was established in 2001 with a mission to facilitate the commercialization and deployment of Intelligent Transportation System projects by working with University researchers, Government practitioners and the transportation industry. CCIT was originally established by the University of California (UC) Berkeley with sponsorship from Caltrans and organized under the California Partners for Advanced Transit and Highways (PATH) research group within the UC Institute of Transportation Studies (UC-ITS Berkeley). Since 2003, CCIT has been operating as a stand-alone center that reports organizationally to UC-ITS Berkeley. However, its goal is to collaborate with all researchers, practitioners and industry professionals on a statewide basis.

While building new capacity remains an important element of transportation improvement, it fails to meet the immediate demands of a growing population and economy in terms of responding quickly to population growth and business needs. We must use transportation innovation to better manage our transportation system and tap its unused capacity. Integrating technology and innovation in existing infrastructure will enable transportation agencies to better manage their facilities and coordinate with others to reduce congestion and improve safety.

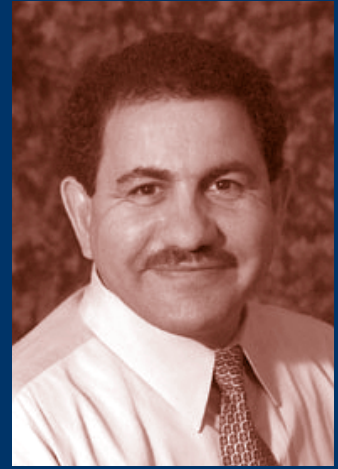
When fixed-timing traffic lights did not meet our needs, we used sensing technology and computer processing to make them more dynamically adaptive to traffic conditions. Now we are attempting to improve ramp metering lights by making them responsive to traffic conditions of both local streets and adjacent freeways, improving throughput and substantially reducing transportation system delays. We must invest more in traffic sensors, performance monitoring systems and traffic management strategies so we can get more out of our existing transportation system and yield higher returns.

For the last two years, CCIT has been focusing on facilitating the implementation of many important tools and services for Caltrans and other transportation agencies. The effective use of these tools and services by operating agencies will reduce congestion and improve safety. CCIT began by working with the Performance Measurement System (PeMS), intended to provide Caltrans with the tools they need to better manage the transportation system, maintain field equipment, develop new strategies, and plan future investments. While researchers in the PATH program are still working on improving future versions of PeMS, CCIT is currently helping Caltrans port the current PeMS system into its daily operations by providing them with technical and training support. In addition, CCIT is focused on providing accurate and real-time information to the traveling public so they can choose a better driving route or decide on a different mode of transportation. CCIT also helps Caltrans and local agencies improve their rail and transit systems through the implementation of technology, such as better information systems and Wi-Fi on trains. These are only a few of the projects that are underway or that have been completed by CCIT. Many more are included in this report and I encourage you to review them.

I hope you get a chance to visit our CCIT website on a regular basis to see the new activities that emerge. CCIT plans to focus on additional areas of transportation, including the use of Intelligent Transportation Systems to meet the needs of homeland security and critical transportation infrastructure protection.



Hamed Benouar  
Director



## DIRECTORS STATEMENT

**“Integrating technology and innovation in existing infrastructure will enable transportation agencies to better manage their facilities and better coordinate with others to reduce congestion and improve safety.”**

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## A WORD FROM OUR MAIN SPONSOR

Over the last few decades, the California Department of Transportation (Caltrans) has been sponsoring research and development of advanced transportation technologies with the goal of improving the safety and efficiency of California's transportation system. More recently, we realized that the outstanding research being performed by university research centers is not always transferred to practical applications in a timely manner. The deployment of research requires collaboration between research centers, industry and government and I am pleased to have worked with dedicated Caltrans professionals and our industry and university partners to establish the California Center for Innovative Transportation (CCIT) at the University of California at Berkeley. It is CCIT's unique mission to bring together researchers, government practitioners and industry professionals to accelerate the implementation of innovative transportation technology to improve the safety and mobility of Californians.

The 2004-2005 year resulted in great strides for California's transportation system. Together with CCIT and many other partners, several initiatives have progressed from the drawing board to day-to-day operations for the purposes of making mobility throughout the state safer and more flexible, while working to preserve and enhance California's resources, investments and its business leadership in the world.

Drivers in the Bay Area can now enjoy trip time messages on freeway changeable message signs, made possible by the first fully automated travel time display system ever deployed in California. Recent advances in computer technology and wireless communications enable CCIT to work with Caltrans, the Capitol Corridor Joint Power Authority and other partners to make wireless Internet connectivity (Wi-Fi) increasingly available on inter-city passenger trains that operate in the three Northern California service corridors. Many more innovations and strategies are underway.

The state's burgeoning population, increased congestion and stubborn environmental pollution have great impact on the operations of California's transportation system and require many more innovative solutions that focus on better use of existing streets and highways and improved transit and high-speed ground transportation systems.

We can't wait to see what additional innovative solutions are applied in the future, and know that however we resolve our current transportation challenges it will be one interesting ride!

Randell Iwasaki  
 Chief Deputy Director  
 California Department of Transportation

### CALTRANS STATEMENT

**“It is CCIT’s unique mission to bring together researchers, government practitioners and industry professionals to accelerate the implementation of innovative transportation technology to improve the safety and mobility of Californians.”**

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## 2005 FEATURED PROJECTS

### Research Deployment

Smart Parking, Affordable Smart Transit Systems (EDAPTS), Performance Measurement System (PeMS) Promotion

### ITS Consulting and Implementation

Displaying Travel Times, GPS for Probe Vehicles, ITS Architecture Planning, Corridor Management, Systems Engineering Diffusion, Innovative Corridors, ITS Decision Website

### Evaluation of Technology

Wi-Fi on Trains, Wireless Traffic Sensors, Emerging Communication Infrastructure, IST 222 Loop Detector Cards, Incident Camera Detection Network (IDCN)

### Support to Research and Innovation

Leveraging International Collaboration, Machine Vision Tracking, Berkeley Highway Laboratory, 12th ITS World Congress

## RESEARCH DEPLOYMENT

This project area is quintessential to CCIT's mission. Through Caltrans sponsorship, we identify research projects that have a high potential for operational and/or commercial deployment. We then work with the researchers and industry partners to extract a finished product from the research results. Along the way, we clear intellectual property rights issues, examine the economic viability and the business models to enable it, identify commercial partners to develop products, and of course, promote and facilitate the adoption of such products by transportation practitioners.

## SMART PARKING

Research suggests that a lack of available parking at public transit stations may discourage ridership. Smart parking employs information technology to manage parking space availability at transit stations and increase effective capacity and transit access.

Combining a dynamic parking inventory management system with a reservation and traveler information system, transit riders use Smart Parking to reserve available parking spaces through the Internet or by phone. Moreover, the system can be linked with changeable message signs that alert freeway drivers of parking availability at nearby transit stations.

The Smart Parking concept was initially developed by UC Berkeley's Partners for Advanced Transit and Highways (PATH), and CCIT has joined the effort in the past year to promote operational deployment.

Throughout 2005, PATH has conducted a Field Operational Test on 50 parking spaces at Oakland's Rockridge BART station with the support of Caltrans, BART, and private partners, including Parking Carma as the system provider. Two changeable message signs located on Highway 24 display real-time parking space availability and location information. The main objective of the FOT is to test commuter's response to the system.

During the Field Test, CCIT contracted with Parking Carma to evaluate scalability factors that may influence the next level of deployment for Smart Parking. This study underlined implementation features to bring the system to a large-scale, commercial-grade quality. It also lays the ground work for the development of a deployment package that would allow transit agencies to specify and implement their own Smart Parking system. As a complete implementation handbook, the deployment package would also assist transit agencies in understanding the benefits and costs of the system, thus encouraging deployment efforts. The development of the deployment package would greatly exemplify CCIT's core mission of investigating, advancing and promoting research results.

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## PERFORMANCE MEASUREMENT SYSTEM (PEMS) PROMOTION

<http://pems.eecs.berkeley.edu/>

Measuring the performance of the transportation system is an essential activity of any Department of Transportation or local traffic management agency. In the area of mobility, performance is typically measured by the amount of delay drivers encounter compared to a free flow situation. Performance measurement is a strategic instrument to track long-term changes and assess the effectiveness of investments and policies. It also serves as a tactical means for day-to-day management of the system that improves operations.

The Performance Measurement System (PeMS) is a software tool designed at UC Berkeley to host, process, retrieve and analyze road traffic conditions information. The PeMS database logs data from California freeway traffic detectors, as well as incident-related data from the California Highway Patrol (CHP) and weather data. PeMS features a web-based Graphical User Interface (GUI) that provides the ability to extract various representations of the data. PeMS holds value for all interested in obtaining real-time or historical traffic information, be it for operational, planning or research purposes.

PeMS was started as a PATH research project and is already in use at Caltrans and in the research community. In 2006, CCIT will lead two major initiatives towards a full operational deployment. The first one will be the installation of computer and networking hardware to allow Caltrans to host its own copy of the software. The second one will be a focused training plan to boost PeMS usage among operations and planning personnel. The training is intended to be introductory and practical, and will be presented in a perspective of continuity rather than rupture with existing methods. Yet, performance measurement does not always receive the desired level of attention from Caltrans personnel. Adopting tools such as PeMS could not only immensely improve the performance measurement capabilities of the Department, but also bring about cultural shifts in a way that the operators think about system management and level of service.

## AFFORDABLE SMART TRANSIT SYSTEMS (EDAPTS)

The Efficient Deployment of Advanced Public Transportation Systems (EDAPTS), a research project currently deployed in San Luis Obispo, California, is nearly ready for commercialization. The EDAPTS Smart Transit System project has been an effort in applied research and development to demonstrate that a low-cost transit management system can be built that provides tangible benefits to system stakeholders. The research was developed by the California Polytechnic State University in San Luis Obispo with sponsorship from Caltrans.

In order to diffuse the benefits of this successful research project, Caltrans' Division of Research of Innovation is investing in the Stage V of the research, the commercial deployment of EDAPTS. A multi-disciplinary research team from Cal Poly Pomona and Cal Poly SLO, with support from CCIT, is leading an effort to investigate the system's costs and benefits, procurement options, and to implement a test deployment at Cal Poly Pomona.

In parallel, CCIT is proposing to start integrating the products of the EDAPTS research into a comprehensive deployment package and establish industrial partnerships. CCIT will also seek prospective users among transit agencies in small and rural communities throughout the state of California, and enable the deployment of EDAPTS in those communities. By collaborating with the Cal Poly research team, CCIT aims to demonstrate a deployment model in which promising research is made into a commercial product that can then directly enhance practice.

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## ITS CONSULTATION AND IMPLEMENTATION

CCIT hires talented engineers and transportation researchers, who together combine outstanding knowledge of Intelligent Transportation Systems (ITS), as well as design and development capabilities. We can help our sponsors make the best use of their existing ITS infrastructure as well as recommend new investments. We also develop and deliver turn-key systems, leveraging our unique relationship with Caltrans to directly impact its daily operations.

### DISPLAYING TRAVEL TIMES

CCIT is currently deploying a system to automatically display travel times on freeway Changeable Message Signs (CMS) in the Bay Area. The system began operating in May of 2005 on two signs placed on I-80, and show driving times from Berkeley to downtown San Francisco and the Carquinez Bridge. The raw data is collected by the 511 system from the FasTrak program and automatically fed to Caltrans' CMS through software developed by CCIT. A survey is currently being conducted to gauge the public's reaction to the first two signs deployed as part of this project. If the evaluation proves successful, the system will be expanded to most of the Bay Area by mid-2006.

Drivers greatly benefit from this project that provides them with information on current traffic conditions while they are commuting. Trip time is the most practical information that commuters can use to assess traffic and adjust their routes. Being aware of driving times to popular destinations, travelers may be able to choose an alternate route early if it appears that their intended route is too congested. In addition, this project takes advantage of the existing CMS installed throughout the Bay Area and uses them for an innovative purpose that is widely understood by the driving public, improving visibility of California's commitment to intelligent transportation systems.

CCIT is currently adding more sign coverage and developing graphical user interfaces to allow Caltrans personnel to take full ownership of the system. Additionally, CCIT is partnering with PATH on conducting additional research on the appropriate set-up and operations that can best leverage such a system to improve traffic. As part of these investigations, we will soon add an interface to make the PeMS database the primary source of traffic data and enable deployment outside the Bay Area, where 511 is not yet available.

### ITS DECISION WEBSITE

[www.calccit.org/itsdecision/](http://www.calccit.org/itsdecision/)

The ITS Decision Website is a gateway to ITS technologies and services. It has a wealth of information, reports and summaries that offer objective information about ITS technologies and services.

This website was designed for a wide audience—ranging from engineers, professionals and researchers to planners, decision makers and the general public. Aside from serving as a remarkable database, professionals and decision makers can use the ITS Decision Website to observe how an ITS technology worked elsewhere and determine what could work in their area.

Several website tools have been developed to address user-specific needs for possible ITS solutions. The three tools are:

- **Expert-system:** the system asks you to describe your local transportation system and your area of concern, then guides you to a potential ITS solution on the site. A description of your local transportation system includes details like the population of the project area and types of transportation system proposed.
- **Case-based reasoning:** the system finds transportation program case studies around the country most similar to your setting that address your areas of concern. The case studies are organized and include comments from those who implemented the programs.
- **Caltrans Transportation Planning Program:** a cost-benefit analysis model that enables economic analysis.



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## GPS FOR PROBE VEHICLES

Once a year, the Highway Congestion Monitoring Program (HICOMP) of the California Department of Transportation (Caltrans) issues a comprehensive report on congestion levels for almost 2,300 miles of the state's most heavily traveled freeways. Much of the data is gathered by probe vehicles, which make trips over pre-determined segments and measure the time needed to complete a route. The rest of the data is generated by loop detectors. Currently, the probes use tachometers that register wheel ticks to determine the distance they have traveled. The driver manually notes the start and end times and the route taken, and all the information is stored on a laptop in the vehicle for off-loading and off-line analysis later.

In 2004-2005, CCIT investigated the feasibility and desirability of replacing the current tachometer system with one that uses GPS units to automatically track the location, speed and route of the probe, then integrate the information directly into the PeMS database and generate reports. Over ten GPS models have been tested and the choices have been narrowed down to two systems selected for their ease of use, robustness, and compatibility with existing HICOMP tools. Several Caltrans districts have been interviewed to understand their existing procedure and how they feel it could be improved using GPS.

With good technical results and positive feedback from Caltrans practitioners, CCIT is now developing a prototype that will be delivered by mid-2006. Route and timing information will be provided by GPS. The data collection software will be either off-the-shelf or an upgrade of existing Caltrans software. Additional software developed by CCIT will take the raw GPS latitude and longitude information, collected at 1-second intervals, and tag it with identifiers showing the freeway measured, the direction traveled and the post-miles covered.

The new system will be more efficient and more accurate because:

- GPS measurements provide absolute timing and positioning, suppressing the need to manually input calibration data for probe runs.
- The GPS unit can be used in any vehicle, whereas the tachometers are permanently installed in a few selected vehicles.

Access to the data will be easier and faster because:

- Data will be stored in a structured database, eliminating cumbersome file manipulations.
- The database will allow easy online access on a continuous basis for performing analysis, and historical data will be available along with the current year's data.
- Ultimately, some of the reporting needs may be generated automatically from the database.

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## ITS ARCHITECTURE PLANNING

Intelligent Transportation Systems (ITS) generally incorporate wireless and electronic technologies, including sensors, signs, and controllers to improve transportation systems. When integrated into the transportation system's infrastructure, and in vehicles themselves, these technologies relieve congestion, improve safety and enhance American productivity.

The recently completed Statewide Intelligent Transportation System (ITS) Architecture and System Plan for California provides a blueprint for the development and application of ITS projects to systematically improve the operations of the state's surface transportation networks. Currently, many state and regional agencies do not incorporate ITS into project planning and coordination. One key focus area of the resulting plan is regional ITS services that have the potential for added value through coordination with adjacent regions and/or state-level projects.

CCIT has recently embarked on a project to help regional agencies adopt ITS technology, and implement a California Statewide ITS Architecture and System Plan with an emphasis on partnerships among public agencies for inter-regional project planning and coordination. This effort directly supports the California Department of Transportation (Caltrans) Director's number one goal: partnering as well as the GoCalifornia initiative. Stakeholders who will benefit from this project include multiple divisions and districts of Caltrans and several regional and local agencies.

CCIT manages the overall project, working with the support of Kimley Horn and Associates and Caltrans staff. CCIT is also making recommendations, analyzing data, and facilitating communication. In addition, CCIT is identifying potential industry partners to participate in this project. CCIT will outline the potential role of each partner and create partnership proposals.

## INNOVATIVE CORRIDORS

The Innovative Corridors Initiative (ICI) seeks to accelerate the deployment of Intelligent Transportation Systems (ITS) technologies, products, and services along major California corridors and to develop a better understanding of ITS and its role in transportation system management.

In Fall 2003, the California Department of Transportation (Caltrans), the Metropolitan Transportation Commission of the San Francisco Bay Area (MTC), the Los Angeles Metropolitan Transportation Authority (MTA), the Intelligent Transportation Society of America (ITSA), and CCIT released the Call for Submissions (CFS) to solicit industry to deploy pilot demonstrations of innovative ITS technologies. The purpose of the pilot projects is to test and illustrate traveler services that facilitate mobility, convenience, and safety to travelers. A unique feature of the CFS is that no funds were awarded. The pilot demonstrations will operate during and after the 2005 ITS World Congress.

As a result of the CFS, Caltrans and MTC have entered into the following public-private partnerships that provide limited access to data and/or rights-of-way in return for data and/or products designed to help the traveling public and transportation managers:

- Circumnav Networks Inc., Caltrans and MTC for a Dynamic Route Advisory Navigation System.
- ENCOM Wireless Data Solutions and Caltrans for Seamless Wireless Integration for Traffic Applications.
- Infotek Associates and Caltrans for Intelligent Loop Detector.
- NAVTEQ and Caltrans for Vehicle Infrastructure Cooperation Demonstration.
- NAVTEQ and MTC for a 511 Level Two Demonstration.
- Outreach and MTC for Bay Area Web Congestion Mapping and Traffic Forecasting.
- SpeedInfo and Caltrans for Speed Sensor Demonstration.
- Tele Atlas North America and MTC for TV511 Demonstration.



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## CORRIDOR MANAGEMENT

CCIT leads a project team that aims to develop a template for corridor system management in California. Its goals are to incorporate detailed multi-modal performance measurement and operational analysis into the traditional corridor planning efforts. Infrastructure expansion, although still an important strategy, can not be the only strategy for addressing the mobility needs of Californians. System management is needed to get the most out of the current system and must be an important consideration as we evaluate the need for facility expansion investments.

Partners involved in this project include regional, local and congestion management agencies. Researchers from the University of California campuses (Berkeley, Irvine and Davis) are supported by System Metrics Group and Cambridge Systematics Inc.

Simply stated, the system management philosophy begins by defining how the system is performing, understanding why it is performing that way, and then evaluating different strategies, especially operations centric strategies, to address deficiencies. The strategies are tested using simulation modeling to allow for more accurate estimation of the benefits.

The study will result in a template for Caltrans to use in corridor planning efforts that will integrate both planning and operations. This will help to address the problem of lost system productivity during congestion, thereby improving mobility in the most cost effective manner.

There are the three corridors being studied. The first one is the I-880 freeway corridor which is located east of San Francisco. It is a 37-mile long traffic route and included in the simulation is 163 actuated signals, 20 fixed-time signals, and 149 traffic responsive ramp meters. The second is the SR-41 corridor network, located in Fresno, CA. This simulation study aims to reproduce real-world peak AM and PM congestion patterns in microscopic simulations, as well as evaluate short or medium term operational improvements based on the calibrated network. The third corridor is the I 5 corridor in Orange County. This study is currently being initiated. These studies use mainly Paramics microsimulations and will evaluate a number of scenarios.

## SYSTEMS ENGINEERING DIFFUSION

The Caltrans Division of Transportation Planning (DOTP) is incorporating Intelligent Transportation Systems (ITS) into its planning, project development, and overall business policy. Caltrans has a good systems engineering approach to implementing traditional projects. However such an approach does not address all the needs of ITS projects. This project will assist Caltrans in implementing ITS projects using a systems engineering approach. This will also assist Caltrans in meeting federal rules that require that all federally funded ITS projects use Systems Engineering analysis. CCIT is undertaking this project, with the support of ASE Consulting and Ice Consulting.

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## EVALUATION OF NEW TECHNOLOGIES

Over the past five years, the ITS industry has been rife with new products and innovations. Keeping up with the multitude of opportunities and options available can stretch the Department of Transportation's resources beyond what is desirable. By cultivating industry relationships and constantly scrutinizing the market, CCIT can identify the most promising technologies and independently evaluate their performance. We act as a point of contact for many companies that wish to do business with Caltrans and our research partners, and we also develop our own prototypes to get first-hand experience with the latest technology trends.

### WI-FI ON TRAINS

Wireless Fidelity, or Wi-Fi, uses radio signals to provide Internet access to portable devices inside a local hotspot. Wi-Fi hotspots are being added to areas convenient to potential users, such as passenger trains. Beyond creating a more productive and pleasurable traveling environment, Wi-Fi on trains can improve train safety, security, and efficiency.

CCIT provides operational support for ongoing research and field tests of Wi-Fi on inter-city railways. CCIT is also developing a decision framework for selecting wireless Internet access vendors on behalf of customers riding the three California state-sponsored Intercity Rail services.

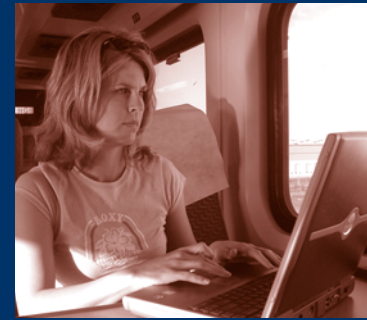
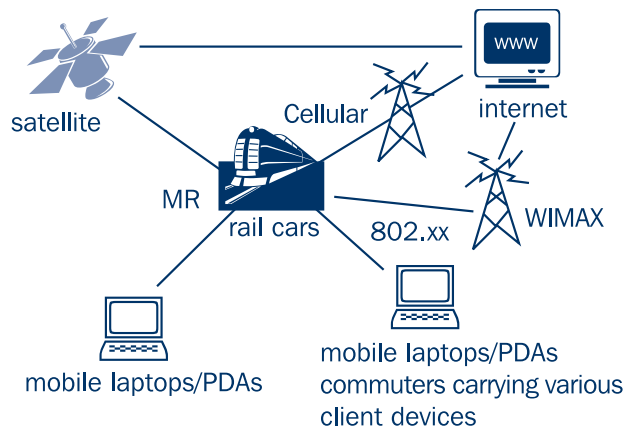
For an ITS technology to be adopted, it must work consistently and be cost-effective. Wi-Fi has already been implemented in many airports and on some railways. CCIT looked at existing Wi-Fi deployments, both nationally and internationally, researching technology options and business models to create and evaluate several potential business plans.

Wi-Fi has potentially broad applications for improving train operations and safety. CCIT is researching and analyzing these applications. This work complements a grant from the Department of Homeland Security to improve train security.

As shown in the adjacent diagram, laptops and Personal Digital Assistants (PDAs) work by accessing radio, cell phone towers or satellites.

Wi-Fi on trains will attract new rail riders and reduce congestion and pollution in the region, enhance regional rail system security and increase productivity and efficiency.

This project is coordinated with a related project in France as part of the CCIT CalFrance Collaboration, which will allow information and staff exchanges. The Central Japan Railway Company is also supporting an exchange of information and scholars.



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## EMERGING COMMUNICATION INFRASTRUCTURE

Caltrans has invested significant resources in technology to help manage the State transportation system. These investments include ITS technology: ramp metering systems, loop detectors, closed circuit television cameras, weather stations and changeable message signs. These devices must communicate with the Transportation Management Center (TMC) in their local areas. Each TMC needs to communicate with other TMCs and send data to a central repository. Communication is also needed to control ITS tools and transmit data to the TMC and the archived database. Currently, Caltrans relies on an outdated and inefficient communication system.

CCIT is helping Caltrans create a long-term cohesive and efficient communications infrastructure. This planning and analysis will reduce costs and support new applications. To create a workable plan, CCIT will analyze Caltrans' technological investments for their advantages and disadvantages. Caltrans has substantial existing investments in older technology, such as 30-year-old loop detectors. CCIT will analyze existing as well as emerging technologies to find the best fit between costs, user functional requirements and reliability. CCIT is supported by Accelerero Systems Inc.

### PROJECTS

## Evaluation of New Technologies



## WIRELESS TRAFFIC SENSORS

CCIT is evaluating a new generation of wireless traffic sensors that use micro-scale components (referred to as MEMS, or Micro Electro-Mechanical Systems). The vast majority of California's traffic sensors are inductive loops. Even though their technology is well established, they are notoriously hard to install and fix, because doing so requires lane closures and construction work. Installing inductive loops also requires many wiring splices and connections that cause data errors. Wireless sensors, because of their size and their capabilities, are less intrusive, easier to set up and potentially more accurate in vehicle detection and classification. They are a good candidate for replacing or supplementing existing loops wherever it is needed.

The product that is receiving consideration for this evaluation is manufactured by Sensys Networks of Berkeley. CCIT and Caltrans are completing the installation of ten sensors in five freeway lanes at the Berkeley Highway Lab (BHL), a freeway testbed on Interstate-80 in Emeryville. The objective is to measure the overall quality of the wireless sensors and their conformity with Caltrans' requirements for this class of products. In doing that, CCIT is boosting Caltrans' new product evaluation process and potentially accelerating the adoption of innovative technology that could improve data collection and traffic control while saving the department millions of dollars.

As part of this study, CCIT also aims to develop specific metrics for generally measuring traffic sensor data quality with respect to accuracy, completeness, validity, and timeliness. Such metrics are being drafted in compliance with Federal Highway Administration guidelines on data quality. The objective is to establish performance standards that can be used uniformly to benchmark sensing technologies. Leveraging the BHL infrastructure, CCIT is implementing a process to generate these data quality metrics automatically for any sensor type.

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## IST-222 LOOP DETECTOR CARDS

Caltrans collects freeway traffic data from tens of thousands of loop detectors on urban freeways. These data feeds are becoming increasingly important in intelligent transportation system management. The detector card, the interface between the loop detector and the controller, is a common source of failure in the system. Recently, new detection systems have been developed that leverage Caltrans' investment in the existing loop detector network. They provide better data quality and support advanced applications. This project evaluates a new 222-type loop detector card manufactured by Inductive Signature Technologies (IST). We are testing whether data quality can be improved, and under what conditions, by simply replacing existing detector cards with the IST cards.

The IST card has several promising features. It is self-configuring, and can therefore adapt to changing conditions without operator intervention. Also, a USB port on its front panel can be used both to extract data and to reconfigure its internal settings.

We have deployed IST-222 cards to 17 freeway detection stations around the Bay Area. These detector cards are connected to PCs inside each cabinet, which collect the data and send it to CCIT over a wireless network. This alternate data path is being used to assess the effectiveness of the IST cards, its remote reconfiguration feature, and the reliability of the nominal data path.

## INCIDENT DETECTION CAMERA NETWORK (IDCN)

The Incident Detection Camera Network (IDCN) uses cameras to monitor traffic, alerting officials to potentially dangerous highway or road conditions. Remote cameras photograph vehicles and send the compressed videos, through an Internet channel, to a data collection point. IDCNs set off incident and non-incident alarms when they detect certain dubious traffic conditions.

CCIT evaluated the performance of two IDCN systems, Citilog and Econolite. To evaluate the two systems, CCIT examined their recorded alarms and video footage over a two-month period. CCIT was able to evaluate how well the IDCN systems identified 'incidents' like stopped vehicles or collisions and 'non-incidents' like rain, stop-and-go congestion, water reflection or shadows. CCIT also looked at the number of false alarms each system activated.

The results of this study are available through CCIT.



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## SUPPORT TO RESEARCH AND INNOVATION

Although CCIT acts only in a supporting role in the early stages of research, we strive to facilitate the emergence of innovation in transportation. One way to do this is to promote exchanges between otherwise isolated communities working towards the same goals. Another key activity is the management of a traffic technology testbed made available to transportation researchers, where we offer state-of-the-art monitoring and analysis tools.

## LEVERAGING INTERNATIONAL COLLABORATION

CCIT seeks out international partners to increase the knowledge base of intelligent transportation systems in an effort to improve mobility choices. By resource-sharing, Californians benefit from world-wide cooperation. In particular, effort is focused on transport systems safety, wireless communications, GPS wireless technologies and road pricing, traffic management and surveillance and smart parking.

France has been a frequent collaborator, sending scholars to work with CCIT staffers to share their latest technologies. The French organizations that provides the most synergy with CCIT include ARIEL and INRETS. One of the very first projects under the CalFrance collaboration benefited from the participation of INRETS, or the French National Institute for Transport and Safety Research ([www.inrets.fr](http://www.inrets.fr)). Their staff of 400 researches road safety, driving aids, transport networks and services, sustainability and the environment. More information about INRETS can be located at [www.inrets.fr](http://www.inrets.fr).

Another distinguished partner is the Central Japan Railway, inventor of the fastest magnetically levitated train in the world, reaching speeds of over 500 kph. JR Central concentrates on technology development related to high-speed railway, and conducts research ranging from technical issues of daily train operations to long-term projects. Their joint research with CCIT in '04/'05 focused on wireless technology on passenger trains, which CJR is also implementing on their rail systems. More information about CJR is accessible at <http://jr-central.co.jp/english.nsf>.

## MACHINE VISION VEHICLE TRACKING

The Next Generation Simulation (NGSIM) program of the Federal Highway Administration (FHWA) has identified a need to substantially reduce the cost of extracting large quantities of vehicle trajectory data from video sequences. In an effort to meet the targeted 20-fold reduction in extraction costs, CCIT has collaborated with Cambridge Systematics, Inc. to develop Caltrack. This software combines a core vehicle detection and tracking algorithm with a user interface that allows the operator to adjust and correct vehicle trajectories as they are being generated. In contrast to other algorithms that use background subtraction to identify moving pixels (i.e. vehicles), Caltrack searches each frame for box-shaped contours, which it then compares to a series of vehicle models. This method has proven to be both more efficient and more robust than background subtraction techniques. Video data from the Berkeley Highway Lab was used to develop and tune the Caltrack algorithm. The prototype dataset consists of 4,733 vehicles covering a 1 km stretch of I-80, and is freely available to the public though the FHWA/NGSIM website.

Microscale traffic simulation models have been around for a long time, but there has always been a lack of data with which to verify and calibrate them. As ITS technologies become more widespread, the need for comprehensive data sets will increase. The Berkeley Highway Lab, coupled with a highly effective machine vision tool such as Caltrack, will be of great value to the transportation community.



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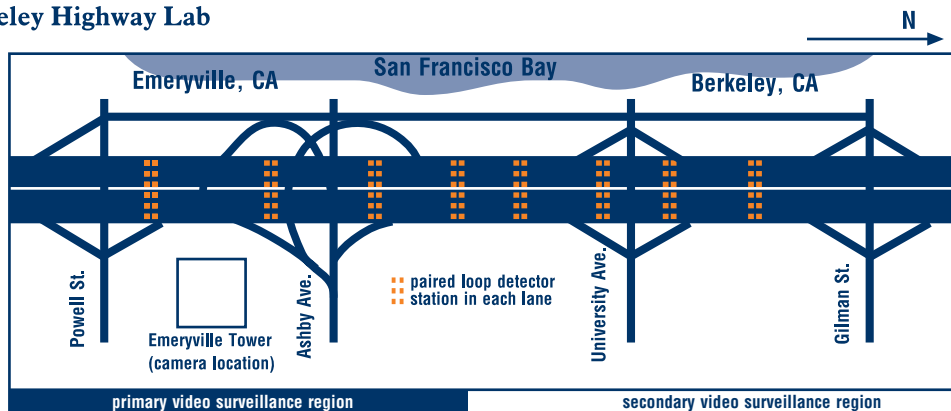
## BERKELEY HIGHWAY LABORATORY

The Berkeley Highway Laboratory (BHL) is a testbed covering 2.7 miles of Interstate-80 immediately east of the San Francisco-Oakland Bay Bridge, as shown in the accompanying diagram. The facility includes 8 digital cameras mounted on an overlooking high-rise building, and sixteen directional dual-inductive-loop traffic detector stations. Applications include traffic studies, simulation calibration and validation, and field testing. The video sensors and loop detectors are a unique resource because they provide high-resolution, individual vehicle measurements that are not currently available elsewhere.

Started as a PATH project in 1999, BHL is managed by CCIT since 2005. From a funding perspective, BHL was structurally integrated with the ATMIS testbed at UC Irvine under the common California testbed denomination. With this new setup, Caltrans funds the management, operations, maintenance, development and promotion of testbeds independently from the research projects that make use of them. The organizational separation between the operator of the testbed and its users is consistent with the vision of an integrated California Testbed that is accountable to the state for its budget and its performance.

CCIT is planning many improvements to the BHL in the year ahead, both small and significant. We are conducting a user outreach survey to better understand our customers. The website will be overhauled to reflect current and future developments. On the capability front, the main enhancements will be in the availability of video footage and its post-processing. Discover more by visiting <http://sprocket.ccit.berkeley.edu/bhl/>.

### Berkeley Highway Lab



## WORLD CONGRESS 2005 - SAN FRANCISCO, CA NOV. 7-10, 2005 ENABLING CHOICES IN TRANSPORTATION

This year's World Congress will highlight the implementation of Intelligent Transportation Systems to enable transportation choices. It will provide firsthand experience of the benefits of ITS. Participants will have the opportunity to attend a number of executive and special sessions with high-level presentations on the latest advancements in ITS. They will then get a chance to try out many ITS technologies and systems through a number of Innovative Mobility Showcase (IMS) demonstrations, like a hydrogen-powered bus that travels through "intelligent" intersections. Other demonstrations include vehicles communicating with other vehicles and the roadway to improve their safe travel through intersections, and to keep them from accidentally leaving the roadway.

CCIT is playing an active and essential role in facilitating this year's World Congress. CCIT Director Dr. Hamed Benouar is participating as a member of the San Francisco Organizing Committee (SFOC) for World Congress and as Chairman of the Board for the California Alliance for Advanced Transportation Systems (CAATS/ITS California), a public/private partnership formed to foster the development and deployment of ITS in California. Mr. JD Margulici, a Senior Development Engineer at CCIT, has taken a leading role in planning the logistics of the IMS. Other CCIT staff is supporting the planning activities and will be involved in the operations at the event, including the opening reception and the IMS demonstrations.



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**California Center for  
Innovative Transportation**

University of California, Berkeley  
2105 Bancroft Way, Suite 300  
Berkeley, CA 94720-3830

Address Service Requested

CCIT thanks the following Partners, Consultants, Principal Investigators, Project Managers, Staff and Students who make CCIT successful:

**PARTNERS AND CONSULTANTS**

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Transcore  
Transportation Research Board IDEA Program

**PROJECT MANAGERS**

Chao Chen  
Bensen Chiou  
Lianyu Chu  
Anne Crowe  
Rachel Finson  
Gabriel Gomes  
JD Margulici

**PRINCIPAL INVESTIGATORS**

Matt Barth  
R. (Jay) Jayakrishnan  
Adib Kanafani  
Timothy Lipman  
Samer Madanat  
Will Recker  
Susan Shaheen  
Alexander Skabardonis  
Pravin Varaiya  
Martin Wachs

**STAFF & STUDENTS**

Mike Angeles  
Simona Babiceanu  
Jeff Ban  
Ypsita Benerjee  
Marika Benko  
Tatjana Bolic  
Sin Yi Chu  
KooHong Chung  
Yi-Chih Hsiao  
Ching-Ling Huang  
Brian Huey  
Eva Khoo  
Yvonne Leung  
David Lewkowitz  
Zeyu Li  
Andre Markarian  
Cindy McCormick  
Polina Mikkelsen  
Xander Mitman  
Cheryl Sershen  
Stella So  
Angela Sugihara  
Rebecca Weaver-Gill  
Samuel Yang  
Wei Zhu



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