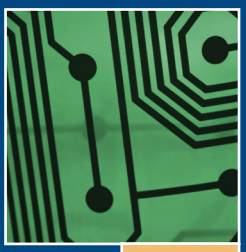
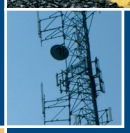
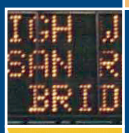
ACCELERATING DEPLOYMENT



2007 Annual Report

California Center for
Innovative Transportation

2007 HIGHLIGHTS

17

DECREASING COMMUTER STRESS

CCIT rolled out upgraded software on 20+ Bay Area changeable message signs. The software offers Caltrans more ways to display travel time information.

17

PROMOTING PUBLIC TRANSPORTATION

Two changeable message signs on the US 101 between San Jose and San Francisco use our software to display the freeway travel time, the Caltrain travel time, and the time of the next departing Caltrain. When a train commute is faster, drivers may pull into the next Caltrain station and cruise on via rail.

20

SHOWCASING INTELLIGENT TRANSPORTATION

Lunchtime ITS deployment workshops, implemented in partnership with ITS California and the Institute of Transportation Engineers, drew an average of 50+ practitioners and experts from research, government, and industry.

15

SUPPORTING DEPLOYMENT GOALS

Planners, engineers, and managers at Caltrans and regional agencies received tailored, hands-on training on useful Freeway Performance Measurement System (PeMS) software features. CCIT trained more than 500 Caltrans employees.

9

INCORPORATING TECHNOLOGY INTO PLANNING

A guidebook for practitioners and a demonstration project are combined to promote the use of ITS Architectures at the regional and state level.

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LETTER FROM THE DIRECTOR
LOOKING FORWARD

Dear Friends,

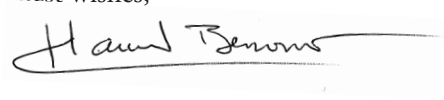
This is the time of year when CCIT reflects on our accomplishments and plans for the future. CCIT spearheaded a number of successful projects this year, and I invite you to read about them in our 2007 annual report. Highlights include a widening of the geographical area where changeable message signs (CMS) display travel times. Our team also upgraded CMS software, offering new features for freeway operators. We completed a statewide training on the freeway performance measurement system (PeMS). Finally, we have received many compliments on our popular deployment-workshop series, which was launched in partnership with the Intelligent Transportation Society of California (ITS-CA) and the Institute of Transportation Engineers (ITE).

To keep up with the growth, CCIT appointed J.D. Margulici to fill the new position of Associate Director—a well-deserved promotion because J.D. plays a vital role at CCIT. One of his first initiatives, with assistance from our Advisory Board, was to revamp our mission statement. Please turn the page to read about this exciting effort.

The publication of this report also marks a fitting end to my tenure at CCIT. As founding Director, I am proud to leave CCIT a vibrant institution and a crucial bridge between research & development and operational practice. Tom West, who recently worked on the Governor's growth initiative in the office of Caltrans Director Will Kempton, is taking over as the new CCIT Director. Tom brings considerable industry experience from a 20-year career at Caltrans that included management positions in research and traffic operations. I look forward to his excellent leadership and fresh vision.

As I move on to join Sensys Networks Inc., I plan to keep in touch and invite you to strengthen your collaboration with CCIT. With your support and partnership, CCIT will continue to introduce and promote innovative solutions that improve the way we manage, operate, and maintain transportation systems.

Best wishes,



Dr. Hamed Benouar

FROM GOOD TO GREAT
SHARPENING OUR VISION

CCIT reexamined its mission, vision, and values in 2007. The goals were to: sharpen CCIT's focus; achieve consensus on CCIT's role and that of its partners; better communicate CCIT's value to its stakeholders; and develop clear, measurable objectives that will steer CCIT's efforts in the right direction.

This strategic planning initiative, largely prompted by feedback from the Board of Advisors, was CCIT's first since 2004. The project was led by Associate Director J.D. Margulici with the help of Dainamic Consulting, Inc.

CCIT'S VISION

CCIT envisions a world where:

- There is a vibrant and competitive private sector vying to provide Caltrans and other public agencies with innovative transportation products and services.
- Publicly-funded research is efficiently diffused into the private sector or builds the transportation industry's body of knowledge.
- Practitioners understand the benefits of adopting new technologies to make the transportation system safer, cleaner, and more efficient.
- Innovations with benefits proven through field testing can be easily procured and broadly deployed in a timely manner.

PARTNERSHIP, COLLABORATION, AND DEPLOYMENT

CCIT's effectiveness depends on successfully partnering with industry to make viable commercial solutions available to transportation practitioners. This may mean helping researchers move new technology from publicly-funded labs to the marketplace. It could also mean evaluating innovative products and services offered by private firms. CCIT is primarily funded through public agencies, such as Caltrans. CCIT operates with limited private sponsorship to preserve intellectual objectivity and avoid any potential conflict of interest.

Another dimension of CCIT's mission is to collaborate with university researchers to enable their work to be turned into products that can be deployed by practitioners. Too many ideas are stuck in the earlier stages of research (see Caltrans' Five Stages of Research Deployment in Figure 1) and never make it into the field. Working closely with the research community, CCIT can facilitate licensing agreements, manage the logistics of pilot deployments, and communicate results to industry and practitioners to ensure timely implementation.

MOVING FROM RESEARCH INTO PRACTICE

Departments of Transportation (DOTs) traditionally struggle with turning research into practice. Recognizing this issue, Caltrans developed the Five Stages of Research Deployment to guide the implementation process. Much of CCIT's value lies in moving innovations past Caltrans' Stage Five to enable widespread deployment. CCIT provides practitioners with objective data and technical assistance to help them adopt innovative technologies, thus creating a critical bridge between research, industry, and government, and ultimately increasing the return on investment of publicly funded research.

CCIT'S NEW MISSION STATEMENT

The California Center for Innovative Transportation (CCIT) accelerates the implementation of research results and the deployment of technical solutions by practitioners to enable a safer, cleaner, and more efficient surface transportation system.

FULFILLING CCIT'S MISSION BY PROVIDING FIVE KEY SERVICES TO ITS STAKEHOLDERS

- **Partnerships & Commercialization**—CCIT works with researchers to identify commercial partners who can develop or productize a promising innovation as early as possible. This also includes facilitating researcher-industry forums to highlight up-and-coming concepts; helping industry partners to work with public agencies; and building interagency partnerships.
- **Technical Implementation Support**—CCIT supports implementation projects during the development stages, including field testing and evaluation, and then helps practitioners implement to enable widespread deployment.
- **Business Cases & Outreach**—CCIT takes on the promotion of new technologies by developing business cases and cost-benefit analyses. This also includes workshops and forums aimed at communicating the benefits of selected innovations and collecting feedback from practitioners.
- **Technology Assessments**—CCIT actively monitors industry trends and identifies technologies that deserve investigations and could benefit transportation practitioners. CCIT also takes a wide-angle approach toward assessing products and services that are already on the market, at times focusing on technologies that come from other industries.
- **Innovation Portfolio Management**—CCIT assists transportation agencies with the management and implementation of publicly funded research. This includes addressing issues such as developing deployment roadmaps, negotiating intellectual property rights, or measuring the return on investment of research.

OUR CORE VALUES

While developing CCIT's revamped mission statement and refining our focus, we also identified a set of core values that defines us as a group.

1. **We commit to user-centered solutions with public benefits.** CCIT, a nonprofit center, deploys innovations that are designed with end users in mind, whether they are transportation practitioners or the traveling public. Technology is the means, not the end.
2. **We promote teamwork, fresh ideas, and open communication.** CCIT believes that individuals with diverse educational and professional backgrounds can make important contributions toward solving transportation challenges. We listen to one another, our partners, and the public.
3. **We seek excellence through intellectual honesty and an entrepreneurial spirit.** CCIT stresses objectivity and persistence. We look for innovative approaches that target practical outcomes.

Reviewing our mission, vision, and values has reaffirmed that CCIT plays a unique role in helping the transportation community leverage research and technology. It enables us to set clearer targets to measure our achievements. Our new mission statement will guide our communication to stakeholders and partners in the foreseeable future.

We welcome your feedback; please share your comments or questions by dropping a note to CCIT at ccitdesk@calccit.org.

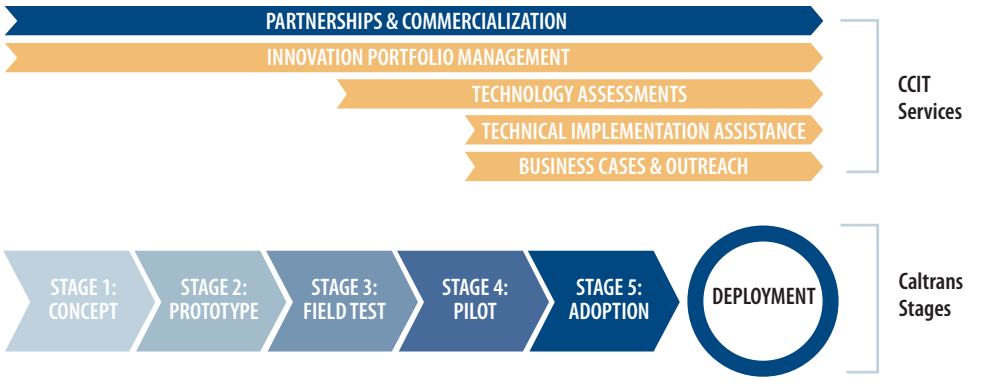


Figure 1: CCIT services, shown where they further the Caltrans Five Stages of Research Deployment

CCIT PROJECTS AT A GLANCE

Our 2007 annual report features 18 projects that encompass a diverse range of transportation topics. A description of each project is presented in the following pages. The table below sorts the projects by scope and areas of expertise, also indicating their current stages of deployment.

FEATURED PROJECT	STAGE OF DEPLOYMENT	AREA OF EXPERTISE	PARTNERSHIPS & COMMERCIALIZATION	TECHNICAL IMPLEMENTATION ASSISTANCE	BUSINESS CASES & OUTREACH	TECHNOLOGY ASSESSMENTS	INNOVATION PORTFOLIO MANAGEMENT
Making the Case for Rubber Pavement	5	Infrastructure Management			●		
Business Case: A Wide-Area Wireless Network for ITS (Telesaurus)	N/A	ITS	●		●	●	
Berkeley Highway Laboratory	N/A	ITS		●		●	
Statewide Architecture: An Interregional Project Demonstration	5	ITS	●	●	●		
Telecommunications Infrastructure Plans for Traffic Operations	5	ITS				●	
Optimal Deployment of Highway Traffic Detectors	N/A	ITS			●	●	
ITS Decision Website: Making ITS Accessible	N/A	ITS		●	●		
EDAPTS—Small Transit Property ITS Program	5	Rail & Public Transit	●	●	●		
Corridor Management: Template and Demonstration	3 4	Traffic Management		●	●	●	
Filling Traffic Detection Gaps on HOV Lanes	4	Traffic Management	●	●		●	
Performance Measurement: Training Planners and Engineers	5	Traffic Management	●		●		
Performing Vehicle Classification in PeMS	5	Traffic Management		●			
Business Case: Statewide Highway Travel Times	N/A	Traveler Information	●		●		
Displaying Travel Times on Changeable Message Signs	5	Traveler Information		●			
Procurement of Innovative Technologies by Transportation Agencies	N/A	Interdisciplinary					●
REDS—Management of Research and Innovation Projects Portfolio	N/A	Interdisciplinary		●			●
Deployment Workshops and Outreach Events	N/A	Interdisciplinary	●		●		
Homeland Security Technologies: Tools for Practitioners	3 4	Interdisciplinary		●			

INFRASTRUCTURE MANAGEMENT

MAKING THE CASE FOR RUBBER PAVEMENT

California citizens generate 32 million scrap tires each year and are expected to generate more than 43 million scrap tires annually by 2020. Approximately six million such tires currently sit in toxic scrap tire piles, even though state policy discourages stockpiling and encourages both recycling and alternative uses. Several years ago, the nation's largest waste tire pile, near Modesto, caught fire and burned for weeks, polluting the air and soil. Simply discouraging stockpiling is not enough and will not keep up with the ever-growing mountain of toxic waste scrap tires accumulating throughout California.

Assembly Bill (AB) 338, passed in January 2007, instructs Caltrans to gradually phase in the use of rubberized-asphalt concrete (RAC), which is made from crumb rubber derived from scrap tires, on state highway construction and repair projects. This law not only acts to reduce our state's growing waste tire piles but will also result in substantial savings. Since RAC is more durable and has a significantly longer lifespan than conventional asphalt, AB 338 will eventually save the state $2 million or more each year.

To assist Caltrans meet the requirements of AB 338 and to support the California pavement program, CCIT works with the Rubber Pavements Association (http://www.rubberpavements.org/) to adopt rubber pavement strategies on California freeways. This ongoing work aids in transitioning to rubber pavement specifications as a Caltrans-wide standard.

BUSINESS CASE: A WIDE-AREA WIRELESS NETWORK FOR ITS (TELESAURUS)

CCIT is exploring the feasibility of developing a wide-area wireless network to provide essential applications of Intelligent Transportation Systems (ITS) that enable traffic efficiency, pollution reduction, emergency response, augmentation of GPS, and other high public interest objectives. The project is sponsored by Telesaurus, LLC, of Berkeley, CA.

Over several years, Telesaurus has acquired a large amount of licensed radio frequency spectrum in the lower 200 MHz and 900 MHz ranges. Its 900 MHz licenses were issued by the Federal Communications Commission in the mid-1990s for location, data, voice, and other transportation-related radio services.

Telesaurus' owners are interested in deploying national, wide-area wireless services through a socially beneficial approach and in coordination with national and local governmental agencies. Toward that end, Telesaurus is in the process of donating most of its spectrum to a non-profit organization, the Skybridge Foundation.

CCIT is working with Telesaurus to determine the key features of a wide-area wireless network that would generally serve the transportation sector. The project goals include refining the overall concepts and plans associated with the deployment of such a network, and assessing its economic and technical feasibility.

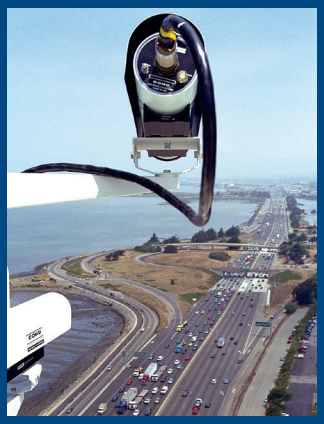
To better understand the potential applications of a wide-area network, CCIT surveyed existing and potential wireless services for the transportation industry. The project team grouped these into 20 application classes, which range from basic passenger-information services to law-enforcement applications to on-demand entertainment services. CCIT is examining the complementary goals and technical capabilities between a wide-area network and the federal Vehicle Infrastructure Integration initiative, which is based on short-range communications.

Additionally, the project team is evaluating basic technology options, including telecommunications protocols, network architecture, and hardware requirements. CCIT is facilitating outreach to public and private entities and promoting Telesaurus' plans to potential stakeholders.

The objective is to develop a business plan that can be widely shared and understood throughout the industry. The business plan can be followed by a pilot deployment, showcasing the practicality and potential benefit of a wide-area wireless network to enable ITS transportation applications.

THE BERKELEY HIGHWAY LABORATORY (BHL)

The Berkeley Highway Laboratory (BHL) is a test site covering two miles of I-80 immediately east of the San Francisco-Oakland Bay Bridge. Sponsored by Caltrans and maintained by CCIT, BHL is used by transportation researchers to conduct investigations and test technology in a real-traffic environment.



Applications of BHL include micro-traffic studies, simulation calibration and validation, and field-testing of detection equipment and other hardware. Because of its extensive traffic monitoring capabilities, the BHL is useful for testing pilot projects.

This year, CCIT overhauled the BHL website and placed it under its own domain (http://bhl.calccit.org). Site visitors can find a running archive of one week's worth of one-frame-per-second video. The site now provides a simplified interface and user-friendly content.

CCIT has used the BHL to set up and test a WiMAX network that connects various field elements at BHL. A promising wireless standard, WiMAX, or a close cousin, may soon become an attractive option for public transportation agencies to provide data backhaul for field elements. CCIT is deploying and evaluating a WiMAX network to demonstrate that potential and improve operations at BHL.

The BHL includes eight cameras, sixteen directional dual-inductive-loop-detector stations sampling at 60Hz, and an array of Sensys wireless magneto-resistive detectors, all dedicated to monitoring traffic for research purposes.

During the 2006-2007 fiscal year, BHL hosted several Caltrans and academic research projects, including the following:

- A joint effort between Cal State East Bay and Ohio State University to explore the possibility of using vehicle re-identification algorithms to provide loop-diagnostics and travel times using the existing loop detectors' infrastructure.
- Ph.D. candidate Nawaporn Wisitpongphan of Carnegie Mellon University used BHL data to find headway distributions in calibrating a traffic model to help test a vehicle communications protocol.

STATEWIDE ARCHITECTURE: AN INTERREGIONAL PROJECT DEMONSTRATION

In order to improve mobility across California, Caltrans is committed to a comprehensive system management approach that values productivity, reliability, flexibility, and safety. Relying on objective performance, this approach is illustrated by a pyramid (see Figure 2) that establishes a hierarchy of strategies ranging from smart-land use to cutting-edge traffic management.

ITS is a key component of the system management strategies because it provides the backbone of modern traffic operations based on real-time information and response. In order to implement ITS on a large scale, architectures have been developed to address the complexity of integrating information technology. The ITS architecture is the planning framework for integrated ITS project development in a specified region, and is most simply described as an ITS system plan.

The goal of this project is to disseminate California's Statewide ITS Architecture (SWITSA) and system plan. This was accomplished by developing high-level ITS planning and project development guidelines for Caltrans and partner agencies, and planning for an interregional systems-integration project demonstrating SWITSA application.

Caltrans staff acknowledges the need for guidance on ITS and technology integration planning. ITS mainstreaming continues to be a challenge because of the high level of coordination required among multiple organizations. Therefore, an architecture is useful to identify areas of common need and service gaps among neighboring jurisdictions. CCIT developed a guidebook titled *Planning for ITS—A Guide to Incorporating Technology into Transportation Planning and Programming*, intended for transportation planning, operations, programming, and project management professionals.

While developing the guidebook, the team selected the Tri-State Integrated Corridor Management System (TICMS) to demonstrate how SWITSA is used. TICMS is an effort in rural Northern California (Caltrans District 2, headquartered in Redding) to improve center-to-center exchange of traffic-management information across Oregon, Nevada, and the Central Valley. With significant stakeholder involvement, architectures from District 2/COATS and the Sacramento Area Council of Governments were leveraged alongside ITS architectures from California, Oregon, and Nevada to develop a concept of operations and high-level functional requirements. Moving the project forward will establish SWITSA's utility and the importance of ITS planning in achieving mobility goals.

TELECOMMUNICATIONS INFRASTRUCTURE PLANS FOR TRAFFIC OPERATIONS

This year, CCIT partnered with Accelaro Systems, Inc. to develop a 10-year communications network plan for the Caltrans Transportation Management System (TMS). The proposed Communications Plan (Com-Plan) standardizes communications between ITS field elements such as signals and cameras, and Traffic Management

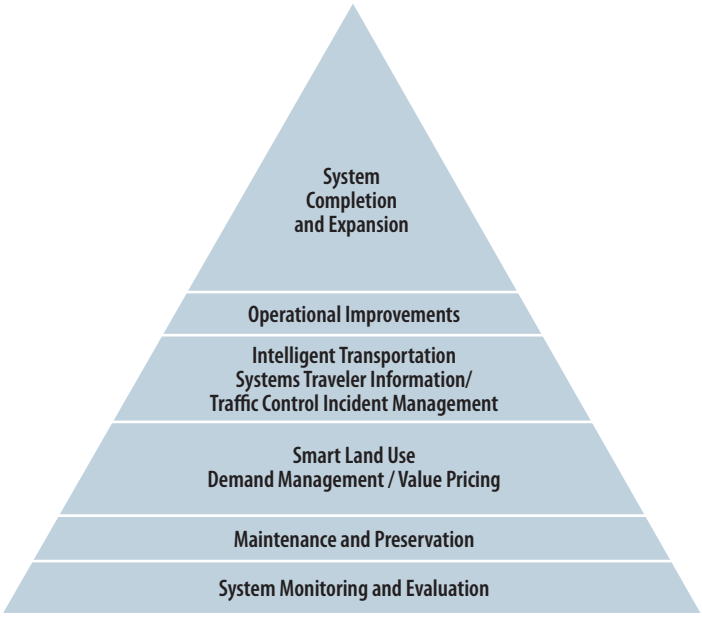
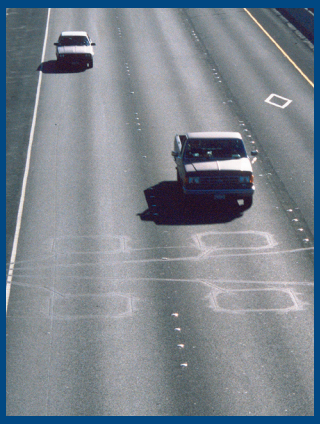


Figure 2: The Caltrans System Management Pyramid
The Caltrans systems management approach is built on a foundation of comprehensive performance measurement.



Centers (TMCs) in Caltrans districts. The two-tier, star architecture is flexible and may be implemented in both urban and rural settings. The Com-Plan:

- Meets Caltrans business requirements
- Increases Caltrans operational efficiencies
- Reduces Caltrans costs
- Supports new Caltrans applications
- Harmonizes solutions across Caltrans districts

To create the Com-Plan, CCIT and its contractors analyzed communication technologies that can transmit data between field elements and Caltrans TMCs. The analysis also included user and application requirements, network reliability, system life-cycle cost, data quality and integrity, and other relevant factors.

The Com-Plan offers Caltrans significant functional, operational, performance, and financial benefits:

- **Functional**: The Plan meets all the requirements for the existing and the future TMS network. Additionally, when implemented, it will enable the development of a superior disaster recovery plan.
- **Operational**: The architecture will enable Caltrans to meet all current operational requirements of the network and will facilitate a cost-effective, planned future expansion of the network.
- **Performance**: The proposed architecture will deliver the performance requirements of the TMS network and improve network availability beyond its current level.
- **Financial**: The cost of implementing the proposed Communications Network (CN) and its impact on the planned expansion of the TMS network over the next ten years reveals the opportunity to realize multi-million dollar cost savings. The proposed system integrates with existing Caltrans infrastructure, which will save costs and add overall value.

OPTIMAL DEPLOYMENT OF FREEWAY TRAFFIC DETECTORS

Various types of traffic sensors, including loop detectors, radar, and video cameras, are widely deployed on highways to provide data for traffic management applications, such as ramp metering control, incident detection, and travel time estimation. However, a systematic analysis of the data requirements of those applications has rarely been conducted, and sensors are often installed on a case-by-case basis without knowing whether the predicted benefits are fully realized.

To provide fresh answers to practitioners, CCIT assembled an impressive line-up of traffic management and modeling experts, under the leadership of Civil Engineering Systems Professor Alexandre M. Bayen.

CCIT will develop a decision-support tool that recommends an optimal, traffic-sensor deployment strategy on a given freeway corridor. Taking into account corridor characteristics such as its setting (i.e. rural/mid-size/urban), ramp locations, number of lanes, and existing sensors, the tool will suggest the locations and types of additional traffic detectors needed to yield a set level of information.

An innovation stemming from this project is the design of quality measures to quantify information from a network of traffic detectors, which is relevant to key traffic applications. The measures are used to express application requirements, and to establish the relationship between sensor deployment strategies and data quality.

For instance, despite radical technical improvements in data collection techniques over the past decade, accurate and timely travel-time estimates remain rare, and systematic studies of their quality are surprisingly sparse. One reason may be that the industry has not developed widely accepted metrics and methods to measure the accuracy of travel time estimates.

Measuring the quality of travel-time estimates is important for the following reasons:

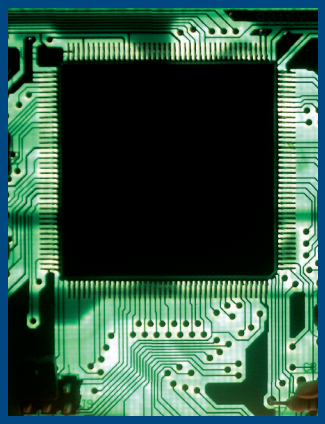
- The margin of error in travel time estimates should be better understood so that drivers and operators can develop adequate expectations.
- Robust validation and monitoring practices for travel-time estimates can point to needed improvements in traffic-data collection and ultimately build up the confidence of network operators in the information.
- In the context of public-private partnerships for data collection, aggregation and dissemination, quality metrics are needed to enable government agencies and technology providers to reach business agreements.

Leveraging those observations, the project team is conducting an extensive benchmark evaluation of travel-time estimates. The methodology and proposed quality measures are intended to set a standard that can be universally applied. Similar efforts are underway to analyze the quality of ramp metering and freeway performance monitoring tools.

ITS DECISION WEBSITE: MAKING ITS ACCESSIBLE
http://www.calccit.org/itsdecision/

The ITS Decision website is a gateway to ITS. The website was designed for a wide audience ranging from engineers, professionals, and researchers to planners, decision makers, and the general public. Professionals and decision makers can use the ITS Decision website to find out how ITS technology is applied elsewhere and to determine what could work in their area.

The website aims to facilitate ITS deployment by offering four categories of information. These categories were developed according to the following human decision-making process: 1. Gather background information; 2. Conduct a feasibility study; 3. Look for similar cases; 4. Obtain a detailed cost-benefit analysis.



Tools have been developed for each of the four steps:

- **Reports and Case Studies**: The website offers an introduction to a variety of ITS technologies and services. Website visitors may obtain background knowledge and information on various ITS applications.
- **Expert-System**: The system asks users to describe their local transportation system and area of concern, then guides them to a potential ITS solution on the site. The description of a local transportation system includes details such as 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 the user's setting that address their 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 enables economic analysis.

Between 2006 and 2007, CCIT developed two expert-system cases. CCIT also added three cased-based reasoning structures to the Cased-Based Reasoning program. CCIT made presentations at the ITS of America annual meetings on the website and gathered feedback on ways to improve it. As a result, the website received attention from both national and international users, as evidenced by a large number of email inquiries and visits to the website.

EDAPTS—SMALL TRANSIT PROPERTY ITS PROGRAM

EDAPTS is an acronym for Efficient Deployment of Advanced Public Transportation Systems.

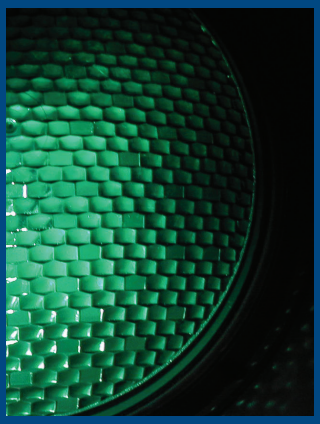
Public transit service providers encounter unique sets of difficulties in small and rural communities, and rural bus riders face uncertainty when trying to catch buses that come only once every hour. The small transit system operator typically struggles with maintaining schedules and experiences elevated safety concerns when buses travel on long routes, especially in remote areas.

Advanced Public Transportation Systems (APTS), a class of intelligent transportation systems, have been developed and deployed in large-scale transit areas. APTS increases transit efficiency and safety, and offers easy access to real-time travel information. However, deploying ITS transit management systems in rural agencies poses a challenge because it is difficult to lower both the initial and the operating costs of APTS, and small or rural operators rarely retain sophisticated in-house technical expertise.

Sponsored by Caltrans, the EDAPTS program has been an effort in applied research and development to demonstrate the feasibility of a low-cost, open-standards transit management system for small or rural agencies. EDAPTS was developed by the California Polytechnic State University, San Luis Obispo (Cal Poly SLO), and operates in the city of San Luis Obispo at SLO Transit. A second demonstration project is underway at the California Polytechnic State University, Pomona (Cal Poly Pomona).

In partnership with the Cal Poly Pomona and SLO research teams, CCIT is working to turn EDAPTS into a statewide program, which will enable the deployment of ITS solutions in small or rural transit agencies. Adoption requires that ITS solutions be commercially available at a competitive price, and be easy to implement and operate. The premise of EDAPTS technology transfer is that the design and the lessons learned from the initial SLO deployment can benefit the industry and also accelerate the emergence of low-cost solutions for smaller operators.

CCIT is identifying possible industry partners, investigating the target market, exploring technology sourcing options, and determining funding mechanisms. The EDAPTS program should ultimately provide funding, streamline procurement, and offer technical assistance to agencies. Once those program elements have been designed, CCIT will phase in the technology with at least one partner agency before taking it statewide.



TRAFFIC MANAGEMENT

CORRIDOR MANAGEMENT: TEMPLATE AND DEMONSTRATION

Promoting management strategies that optimize the current California highway corridor system is important. CCIT's Corridor Management Plan Demonstration (CMPD) project developed a systematic management template and associated tools after studying three corridors: I-880 (Fremont–Oakland, California–East Bay Area), SR-41 (Fresno, California–Central Valley), and I-5 (Orange County–Southern California).

CCIT seeks to demonstrate new methods for corridor analysis by combining comprehensive, multi-modal, performance-measurement, and operational analysis into traditional corridor-planning efforts. We assessed performance using the Freeway Performance Measurement System (PeMS), an advanced, online, freeway data archive and analysis tool. Micro-simulation models were developed to analyze the corridor and evaluate improvement scenarios with Paramics, a micro-simulation software tool.

The project will help Caltrans develop corridor system-management plans that integrate long-range transportation planning with operational analysis. In particular, the project team developed a template and associated tools to assist in statewide Corridor System Management Plan (CSMP) that focuses on stakeholder participation, consideration of major corridor elements, multi-modal performance assessment, analysis model development, and expected future performance under multiple improvement scenarios.

HYBRID VEHICLES ON HOV LANES

A California law allowing selected single-driver, electric-hybrid vehicles to use High-Occupancy Vehicle (HOV) lanes places an additional burden on crowded sections of HOV lanes. This burden potentially degrades lane performance and limits the incentive to carpool.

In fact, the Federal Highway Administration mandates that hybrids not clutter HOV lanes past a set level and requires monitoring speed and traffic flow in HOV lanes. Such monitoring is typically performed by traffic sensors, usually inductive loop detectors. However, long stretches of HOV lanes on California freeways are not equipped with detectors, or are equipped with deficient detectors.

CCIT, with sponsorship from Caltrans, has designed optimal methods to fill the gaps in current HOV-lane monitoring systems. Emerging sensor technology is cheaper and faster to deploy than traditional inductive loop technology. For instance, wireless sensors by Sensys Networks, of Berkeley, CA, collect traffic data of comparable accuracy to that collected by inductive loops, at less than half the life-cycle cost. These sensors take three to four times less installation time, requiring fewer and shorter lane closures.

These capabilities were demonstrated via a pilot deployment at two locations on US-50, and CCIT plans to conduct a pilot demonstration at two more locations on I-80. These tests were deployed in partnership with Caltrans District 3 (Sacramento).

The team also conducted a comprehensive review of detection gaps on HOV lanes in Districts 3 and 4, and drafted deployment scenarios to increase the number of monitoring stations on those corridors.

PROMOTING PERFORMANCE MEASUREMENT

Measuring the performance of the transportation system through metrics such as flows and delays is an essential activity for Departments of Transportation and local traffic management agencies. Performance measurement is a strategic method to track long-term traffic changes and assess the effectiveness of transit investments and policies. It also serves as a tactical means of monitoring day-to-day traffic operations.

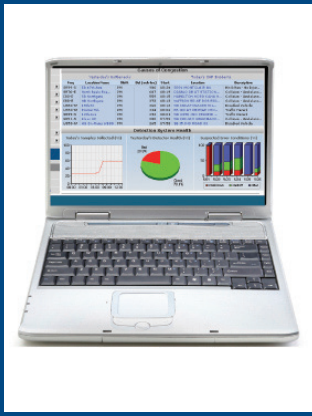
The Freeway Performance Measurement System (PeMS) database logs data from freeway traffic detectors, as well as incident-related data from the California Highway Patrol (CHP) and accident data from Caltrans. PeMS provides the ability to extract various representations of data. PeMS holds value for everyone interested in obtaining real-time or historical traffic information for operational, planning, or research purposes.

From 2006 to 2007, CCIT implemented a focused training initiative to increase awareness, usage, and interest in freeway performance measurement among Caltrans operations and planning personnel. The initial outreach was tailored to three distinct groups at Caltrans: executive management; deputy district directors for planning and operations; and middle-management and staff. Subsequently, CCIT, Systems Metrics Group, and Berkeley Transportation Systems delivered 35 day-long training classes designed to teach hands-on PeMS exercises to over 500 attendees statewide, including staff from several metropolitan planning organizations.

The training was well-received and stressed the importance of archived data, performance measurement, and evaluation as the foundation of good system management. It also opened the eyes of many practitioners to the quality and relevance of PeMS as an everyday tool. The following additional activities will continue to promote performance measurement:

- The training classes will be taken one step further, moving into specialized modules and turned over to UC Berkeley's Technology Transfer Program.
- A PeMS workbook that contains a range of sample exercises will be developed to complement the training.
- An online forum for PeMS users will enable constructive interactions and feedback.
- Continued outreach initiatives and performance measurement workshops will be organized for Caltrans and the staff at local agencies.

PeMS can bring about a cultural shift in how operators think about system management and level of service. This will be increasingly important as transportation agencies bring additional focus on performance measurement to justify investment decisions.



PERFORMING VEHICLE CLASSIFICATION IN PEMS

Freeway Performance Measurement System (PeMS) is a web-based tool designed at UC Berkeley to host, process, retrieve, and analyze road traffic condition information.

While traffic counts are a fundamental and straightforward freeway monitoring measure, they tell only part of the story. Heavy vehicles, such as trucks and buses, impose a much higher burden on bridges and highways than small individual vehicles. The impact of heavy vehicles on traffic is significant because they are slower and occupy more space than lighter vehicles. It is of consequence that pavement wear and tear increases exponentially with vehicle weight. Therefore, the ability to classify vehicles at traffic monitoring stations adds valuable information for transportation operators and planners.

The vehicle mix has implications for demand management, congestion thresholds, corridor safety, and, above all, design and maintenance requirements. Therefore, vehicle classification is an integral component of a comprehensive systems management strategy. The Federal Highway Administration (FHWA) requires regional classification studies to be performed periodically, but they're usually done manually or with temporary setups. CCIT and Berkeley Transportation Systems, Inc. (BTS) partnered with Inductive Signature Technologies (IST) to enhance PeMS and to provide automated vehicle classification at selected vehicle detection stations in the San Diego area.

Funded by the San Diego Association of Governments (SANDAG), the project has enabled improvements to the web-based PeMS graphical user interface, allowing practitioners to directly access vehicle classification data along with other freeway measurements. IST's inductive-loop technology provides automatic vehicle classification data that is streamed to PeMS and can now be stored and retrieved permanently. The classification engine identifies no fewer than 16 different types of vehicles, and this information can be readily used for planning, safety analyses, and project studies.

TRAVELER INFORMATION

BUSINESS CASE: STATEWIDE HIGHWAY TRAVEL TIMES

In December 2005, CCIT hosted a forum on travel times technology and economics in San Diego. The forum brought state, regional, and private-sector practitioners together to discuss cutting-edge, travel time data collection, and dissemination tools.

The Statewide Highway Travel Times project will continue the dialogue that began with the San Diego Travel Times Forum. The project will draft deployment plans for technology that can significantly improve data collection for travel time estimates. This will further the two key points that emerged from the Travel Times Forum:

- Data that is both ubiquitous and reliable is urgently needed to manage California's transportation system.
- Caltrans should intensify partnerships with the private sector to leverage travel information demand and benefit from the latest technological advances.

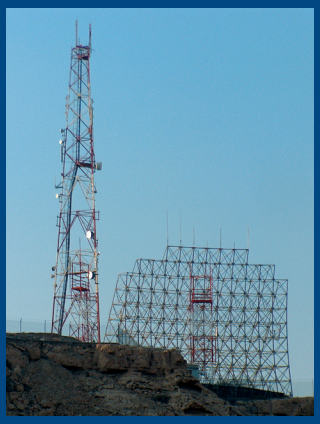
CCIT is focused on helping Caltrans extend the coverage and quality of travel time information using new technologies. Drawn from existing studies and similar initiatives, CCIT is developing metrics to assess the quality of data used for travel time estimates. The assessment will be governed by regular, systematic benchmark evaluations of travel time estimates.

CCIT is also formulating a business case using new technologies and business models that, according to vendors, extend sensor coverage. CCIT has discussed possible business models with traffic data providers. These discussions included providers of Floating Vehicle Data (FVD). The concept of FVD is based on the exchange of traffic-related information between vehicles traveling on the road network and an information system to calculate travel times using different technologies, such as cell phones or GPS devices. Equipped vehicles act like probes on the road network and continuously provide cost-effective, real-time traffic data.

DISPLAYING TRAVEL TIMES ON CHANGEABLE MESSAGE SIGNS

Real-time traffic information on changeable message signs (CMS) has gained popularity in urban areas where congestion and incidents frequently impact vehicle travel. CMS broadcasts information about downstream corridor delays, traffic incidents, and estimated travel times. Displaying accurate travel times on CMS helps commuters assess traffic, alleviates driver stress, and allows drivers to make better route decisions. Knowing the driving times to popular destinations, travelers may choose a less-congested route or a different form of transportation. Moreover, signs are the most effective means to communicate real-time, relevant information to motorists. Unlike a radio broadcast, CMS may be placed where they are most useful to drivers.

For the past two years, CCIT has helped Caltrans deploy an automated system nicknamed MITTENS to display travel times on CMS in the Bay Area. MITTENS relies on the Metropolitan Transportation Commission's 511 system for travel time predictions. These predictions are based on real-time traffic data collected by toll tag



readers/FasTrak, Caltrans' embedded, loop-traffic detectors, and speed-radar data purchased from Speedinfo, Inc. Predictions are updated every minute and reported on the signs.

After a year of delivering messages to over twenty signs in the Bay Area, Caltrans and CCIT saw the need to enhance MITTENS' functionalities. As a result, CCIT developed a new and flexible version of the software. The new system is more easily configured and operable. Different message templates can be specified, scheduled, or activated in response to traffic conditions. Operators also have an easier time adjusting settings, and may now display two-page flashing messages that combine travel times on one page with manually-inputted information on the other page.

The new version of MITTENS also enables displaying transit information along with freeway travel times. In partnership with Caltrain, Caltrans District 4 is comparing driving times with riding baby bullet trains along the US 101 corridor. This feature is designed to encourage motorists to use public transit during rush hours.

The CCIT team provides on-going support and incrementally enhances MITTENS' functionality. Near-term enhancements consist of adding features to the user interface to enable editing train schedules and defining different templates for CMS display. With those improvements, Caltrans will soon be able to autonomously operate and administer MITTENS. The messages will soon be deployed to 20 more signs in the Bay Area, bringing the total to more than 45 out of roughly 100 signs in the entire Bay area.

Finally, CCIT is upgrading MITTENS to allow deployment in other Caltrans districts, including District 3, District 5, and District 10, and to test alternative technologies and processing techniques to calculate travel times. This task includes evaluating requirements and costs associated with deploying new detection technologies in the districts where sensor coverage is not available, or not enough to estimate travel times.

PROCUREMENT OF INNOVATIVE TECHNOLOGIES BY TRANSPORTATION AGENCIES

Public transportation agencies must acquire innovative products and services to improve safety and mobility, yet strict procurement rules prevent buying from sole-source vendors. This sometimes makes it difficult for public agencies to acquire items or services supplied solely by a lone pioneering vendor. Procurement is complicated further when innovative projects are initially supported by public funds, usually in the form of university grants or grants to start-up companies. In such cases, the trade-offs between expediency, long-term value, and adherence to a fair and open procurement process can be difficult to navigate.

CCIT has partnered with the Center for Entrepreneurship and Technology (CET) to examine some procurement challenges faced by transportation practitioners. Under the umbrella of UC Berkeley's College of Engineering, CET serves as a platform for educating scientists and engineers about cutting-edge technology and innovative business strategy. We reviewed six case studies and analyzed the legal and institutional context for procuring innovation. We attempted to answer the following questions:

- How do administrative processes at an organization like Caltrans fit the acquisition of innovative products and services? Is legislation adequate?
- What organizational improvements would streamline innovation procurement and recapture investment in research and development?
- What is the optimal way to attract innovators and give them a head start in developing needed products while remaining fair and open and avoiding becoming "locked-in" down the road?

We identified and illustrated, by example, several critical barriers to innovation. While some barriers are inherent in state law, others can be addressed by applying best practices or by enhancing organizational processes.

Intellectual property is a recurring issue in the implementation of research, one that can delay the deployment of needed innovation. For example, CCIT examined licensing options in the case of the Balsi Beam, a safety device developed by personnel at Caltrans Division of Equipment in response to a serious work-zone accident involving a Caltrans employee. With support from CCIT, Caltrans plans to transfer the Balsi Beam technology, so it can be purchased and deployed among maintenance crews across the state.

REDS—MANAGEMENT OF RESEARCH AND INNOVATION PROJECTS PORTFOLIO

The Research Evaluation Database System (REDS) helps the Caltrans Division of Research and Innovation (DRI) maximize investments, saving California valuable transportation research funding. It is a unique tool that identifies the current state of DRI-funded research, offering comprehensive project information.

CCIT has been improving REDS since July 1, 2003. During the first phase, CCIT collected data on 424 projects. In the next phase, we plan to speed up data collection and input information on 3000 total projects.

CCIT improved REDS' functionality and usability. For example, we reduced the number of steps required to retrieve information from the system, simplifying the user's experience. We also clarified the presentation of project information; the display is now compact and uncluttered. Finally, CCIT improved research assessment and decision support by adding graphical representation of the information, as well as by providing additional standard report forms.

The project team incorporated Caltrans staff feedback and stated needs to determine the areas of REDS that required upgrades. The team conducted end-to-end testing, trained end-users on upgraded features, and updated the user manual.

DEPLOYMENT WORKSHOPS AND OUTREACH EVENTS

CCIT fosters collaboration among researchers, government, and industry by developing and supporting key industry events, including a new Deployment Workshops series. CCIT staff was also instrumental coordinating last year's ITS of California (ITS-CA) annual meeting and participated in the ITS of America (ITSA) annual meeting.

Deployment Workshops

In the spring of 2007, ITS-CA's Northern Section and CCIT, in association with the SF Bay Area Section of the Institute of Transportation Engineers (ITE), proudly introduced a joint lunchtime workshop series that focuses on the deployment of intelligent transportation systems in California. Sponsored by Caltrans, the series is designed to attract a broad audience of transportation professionals at public agencies, private firms, and research centers. Each workshop features introductions to a selected topic from an expert panel, followed by a question and answer section with the audience. The workshops are free, include a hosted lunch and networking time, and are broadcast live over the web for those unable to attend in person.

The first two parts of the series covered congestion pricing and mobile travel times. The workshops were held at the CCIT offices in downtown Berkeley and at the Metropolitan Transportation Commission in Oakland. They each attracted over 50 professionals and have received wide acclaim for the quality of the panels and the richness of the discussions. Please join us in 2007–2008 for more exciting opportunities. We look forward to your feedback and suggestions.

The lunchtime workshop series accompanied other successful deployment events organized by CCIT, such as a day-long conference on WiMax technology and an Interstate-80 stakeholder workshop. Please see the CCIT website for more information on past and future events.

ITSA Annual Meeting

The 2007 ITSA annual meeting offers the intelligent transportation systems community a chance to discuss significant topics and listen to expert speakers. CCIT staff and students were active participants in this year's meeting. We worked with the ITS-CA Board of Directors to host an opening night reception at the Roy Rogers Air and Space Museum, and co-hosted an exhibition table throughout the three-day event.

Moreover, several CCIT staff gave project presentations and participated in technical and poster sessions.

ITS-CA ANNUAL MEETING

As outgoing chair of the ITS-CA Board of Directors, CCIT Director Dr. Hamed Benouar helped ITS-CA form better connections between government, research, and industry.

Last year, CCIT staff worked with ITS-CA to organize and implement its annual meeting. The Sacramento event attracted more than 150 ITS professionals. It featured talks from world-class ITS experts as well as a live showcase of Vehicle Infrastructure Integration (VII) technology.

HOMELAND SECURITY TECHNOLOGIES: TOOLS FOR PRACTITIONERS

CCIT is helping Caltrans improve its preparedness measures and response plans for terrorist attacks and find viable solutions that are not excessively labor-intensive and resource-driven.

Since 9-11, researchers, transportation practitioners, and industry have concentrated on developing new, cutting-edge intelligent transportation technology and safety operation plans. While Caltrans is considered a leader in addressing security issues, both the dynamic nature of ongoing threats and the influx of new technologies require that California develop a long-term system that keeps decision makers up to date on the latest security technologies and best practices.

CCIT is taking the following steps to secure the transportation system and improve Caltrans' preparedness and response to terrorist attacks:

- Research viable security technologies and best practices for preventing, deterring, and mitigating the effects of terrorist attacks. This research will build on existing transportation security work where applicable.
- Create a website hosting security articles and reports, and provide chat rooms for security officers to share and refine best practices.
- Identify and synthesize reports on transportation security and technology, and post them to the security website.
- Conduct seminars for pivotal Caltrans security personnel on these technologies and best practices.
- Create documents on security framework, vulnerability assessment methodology, and host security-related documents and other resources.

This year, CCIT will continue to research security technology and best practices. CCIT is exploring opportunities to formulate a multi-agency partnership to enhance the security website and keep the content up to date after the project ends.

PARTNERS AND STAFF
LEVERAGING CONNECTIONS

PARTNERS

American Association of State Highway and Transportation Officials (AASHTO)

Alameda County Transit

Accelero Systems, Inc.

AMTRAK

Aperto Networks, Inc.

ASE Consulting

Bay Area Rapid Transit (BART)

Berkeley Transportation Systems

Braidwood Associates

CA Department of Transportation (Caltrans)

California State University, East Bay

California Polytechnic University, Pomona

California Polytechnic University, San Luis Obispo

Caltrain

Cambria Solutions LTD

Cambridge Systematics

Central Japan Railway

CoValuate

CQ Consultants

DaimlerChrysler, Inc.

French Ministry of Transports

Glocol, Inc.

Inductive Signature Technologies (IST)

Institut National de Recherche sur les Transports et leur Sécurité (INRETS)

Intelligent Transportation Society of America (ITSA)

Intelligent Transportation Society of California (ITS-CA)

Institute of Transportation Engineers

Kimley Horn and Associates

Laboratoire Central des Ponts et Chaussées (LCPC)

Loragen Corporation

Los Angeles Metropolitan Transportation Authority (LAMTA)

Metropolitan Transportation Commission (MTC)

NAVTEQ

N-Squared Associates

Partners for Advanced Transit & Highways (PATH)

NAVTEQ

San Diego Association of Governments (SANDAG)

Sensys Networks, Inc.

Siemens Gardner Transportation Systems

Speedinfo, Inc.

Systems Metrics Group

Telesaurus, LLC

Texas Transportation Institute

Transportation Research Board (TRB)

UC Berkeley Center for Entrepreneurship and Technology (CET)

UC Berkeley Pavement Research Center

UC Berkeley Technology Transfer Program

UC Davis AHMCT

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LINKING ACADEMIA, GOVERNMENT, AND INDUSTRY

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