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CALIFORNIA PATH PROGRAM  
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# **Operations at Regional Traveler Information Centers: The Case of the TravInfo Field Operational Test – Final Results**

**Mark A. Miller, Dimitri Loukakos**

**California PATH Working Paper  
UCB-ITS-PWP-2000-20**

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The contents of this report reflect the views of the authors who are responsible for the facts and the accuracy of the data presented herein. The contents do not necessarily reflect the official views or policies of the State of California. This report does not constitute a standard, specification, or regulation.

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**Operations at Regional Traveler Information Centers:  
The Case of the TravInfo<sup>®</sup> Field Operational Test —  
Final Results**

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Dimitri Loukakos**

**September 28, 2000**

## **ACKNOWLEDGEMENTS**

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## **ABSTRACT**

TravInfo is a regional traveler information system in the San Francisco Bay Area. It was a Field Operational Test (FOT) over a two-year period from September 1996 to September 1998 with funding from the Federal Highway Administration and the California Department of Transportation (Caltrans). TravInfo's goal was to broadly disseminate accurate, comprehensive, timely, and reliable information on traffic conditions and multi-modal travel options to the public in the Bay Area.

Organizationally, it was structured around a collaborative partnership between and among public and private participants. Operationally, the system was built on an open-architecture concept to make its regional database easily accessible to all parties interested in disseminating traveler information. TravInfo's operational core, the regional Traveler Information Center (TIC), collected and processed information for dissemination directly to the public and to information service providers. It was primarily a manually run operation and so depended heavily on the performance and workload of its staff.

The purpose of this project was to evaluate the operation of TravInfo's Traveler Information Center with a focus on its operation by a private sector contractor. The evaluation of the operation of the Traveler Information Center was performed using various data sources from field observations and field measurements. The evaluation of the Traveler Information Center consisted of technical and institutional elements. The technical component examined system reliability, the communications interface, the operator work setting, and operator performance. The institutional analysis element examined the TIC's operational effectiveness from an organizational perspective, including the identification of both areas of achievement as well as barriers to successful TIC operations. In addition, the deployment of regional traveler information centers in other parts of the country was examined.

**Key Words:** TravInfo, Field Operational Test, evaluation, regional traveler information centers, advanced traveler information systems

## **EXECUTIVE SUMMARY**

TravInfo is a regional traveler information system in the San Francisco Bay Area. It was a Field Operational Test (FOT) over a two-year period from September 1996 to September 1998 with funding from the Federal Highway Administration and the California Department of Transportation (Caltrans). TravInfo's goal was to broadly disseminate accurate, comprehensive, timely, and reliable information on traffic conditions and multi-modal travel options to the public in the Bay Area.

Organizationally, it was structured around a collaborative partnership between and among public and private participants. Operationally, the system was built on an open-architecture concept to make its regional database easily accessible to all parties interested in disseminating traveler information. TravInfo's operational core, the regional Traveler Information Center (TIC), collected and processed traffic information for dissemination directly to the public through the Traveler Advisory Telephone System and to information service providers over TravInfo's Landline Data Server for their product testing. During the field test, three private information service providers deployed traffic Web sites in the Bay Area using TravInfo's data, and a few dozen others retrieved TravInfo data to test a wide range of advanced traveler information products. The TIC was primarily a manually run operation and so depended heavily on the performance and workload of its staff.

The purpose of this project was to evaluate the operation of TravInfo's Traveler Information Center with a focus on its operation by a private sector contractor. The evaluation of the Traveler Information Center was performed using various data sources from field observations, in-person interviews with project partners and Traveler Information Center staff, and field measurements.

While the Traveler Information Center is operated by a private contractor, the Metropolitan Transportation Commission, a public entity, oversees the entire management of the center. The TIC disseminates traveler information directly to individual travelers through TATS, the interactive landline telephone system that can be

reached by dialing 817-1717 (TTY: 817-1718) from all Bay Area area codes, and to information service providers who have registered to participate in the TravInfo project and who tap into the center's database through a modem or telnet connection to the LDS.

TATS provides regularly updated information on current traffic conditions, carpooling, highway construction reports, bicycle programs, San Francisco International Airport ground transportation, and a direct connection to the region's more than two-dozen public transit and paratransit operators. During emergencies and special events, information is added. Monthly call volumes ranged between 50,000 and 65,000. The volumes remained consistent during the field test except on two occasions, the BART (Bay Area Rapid Transit) strike in September 1997 and the floods in February 1998, when volumes rose significantly, but temporarily.

The center operates 24 hours a day, seven days a week. There are three weekday shifts, with the busier morning and afternoon shifts each staffed by four operators and one supervisor and the overnight shift staffed by one operator. During weekends, there are rotating shifts with two operators on duty during the day and one overnight. Two sources of data were fed automatically into the TravInfo database: they were data from the inductive loop sensors of Caltrans' Traffic Operations System and data from the Freeway Service Patrol. But because the loop sensors were not deployed as extensively as anticipated, coupled with their ongoing accuracy and communications-related problems, the most significant data source soon became the Computer-Aided Dispatch incident reports from the Highway Patrol, which required significant interpretation, data entry into the Traveler Information Center's system, and follow-up by the operators. Although the software, overall, allows operators to perform efficiently, the interface has shortcomings and could have been designed to better support them at their tasks.

Because of the manual nature of the TravInfo system, the operators' response time is critical to how well the center meets its goal of timely, comprehensive, and reliable dissemination of traveler information. During the field test, it took an average of 10 to 11 minutes to process an incident from the Highway Patrol's Computer-Aided Dispatch

system and enter it into the Traveler Advisory Telephone System. Approximately 20% of the total number of incoming Computer-Aided Dispatch incidents were entered.

Operators' job performance and their workloads were the two primary factors influencing the number of incidents they entered into the system and the time required to do so.

Numerous operator work activities affect operators' response times, though it was difficult to isolate these activities and quantify their individual contributions to operators' response times. Nevertheless, examining them helps provide a fuller context within which response times can be assessed. These activities included attempts to verify an incident, disruptions caused by operators' shift changes, calls into the phone advisory system for quality-control purposes, updates of an incident already entered into the system, and searches for redundant listings or listings of incidents that do not delay traffic flow. Other factors such as the number and type of incidents reported by the California Highway Patrol, the operator's level of experience, the rate at which incidents arrived, and system software and hardware problems played only a minor role in influencing response times.

The physical environment of the Traveler Information Center proved to be acceptable, and operator performance was not directly related to working conditions. Overall, competent staff was employed at the center, and management oversight measures were taken to monitor performance. Moreover, the center's staff worked to resolve problems and developed good working relationships with outside contractors.

Relying on operators to perform TravInfo tasks proved time-consuming, especially in the transfer of incident data from the Computer-Aided Dispatch system's terminal to the center's system, and from the center's system to the telephone advisory system.

Automating the data entry process, which was part of the system's original specifications, could speed operators' response times and increase the number of incidents they could process, although it is likely that operators would still need to intervene in the interpretation of some incident reports.

By the end of the field test, over 50 information service providers registered with TravInfo. Of that group, 90% were in the private sector. They ranged from local Bay Area firms to large international corporations. Approximately 30 of the private firms retrieved TravInfo data intermittently; three were continuous users throughout the field test.

Several lessons have been learned from the TravInfo evaluation experience. First, the TravInfo system is not as efficient as originally envisioned because of its heavier-than-expected dependence on the manual performance of jobs by the Traveler Information Center operators. That in turn makes it necessary to employ significant measures to ensure the quality of operators' performance. TravInfo needs an automated system that is flexible enough to keep up with rapidly advancing technologies, which will likely require its system components to be enhanced and upgraded. As the system becomes more automated, the organizational structure, which was top-heavy during the field test, can be streamlined since there would be less need to supervise operators and conduct such heavy quality control monitoring.

The traveler information dissemination sector has undergone major changes in recent years in the wake of the digital revolution and the explosion in communication technologies and devices. Few projects of a similar nature to TravInfo were actually in existence at the same time as TravInfo. These were the Los Angeles SmarTraveler and the Boston SmarTraveler. In recent years (1997-98 on) many SmartTraveler type projects were deployed throughout the country under the leadership of SmartRoute Systems Inc.

The private sector has been quite active in the provision of traveler information. Generally, private companies have focused on the provision of traffic information to radio and TV stations. The boom in Internet services has brought about new dissemination mechanisms and revenue schemes. This is still the case but with the recent explosion in media and communications devices (web, cellular, palm pilots, cable and satellite TV, soon in-vehicle satellite radio), information dissemination methods have multiplied and the traditional payment or revenue-generating schemes are also

undergoing changes. Web-based information is generally supported by advertising on the providers' page or is licensed to information or entertainment web sites. Information provision is also becoming increasingly personalized to users' needs and targeted to specific markets. The three main new traveler information provision markets are the Internet, wireless devices (phone and palm pilots) and in-vehicle communications.

The operation of TravInfo's Traveler Information Center during the Field Operational Test occurred in an environment in which the day-to-day operations were managed by a private-for-profit contractor though under the overall management supervision of a public sector consortium of transportation-related organizations. Since October 1998 when TravInfo concluded its Field Operational Test phase and entered a transitional period, the operational environment has remained basically constant with only relatively minor changes. When the new system manager assumes its operational responsibility, ultimate decision-making authority will continue to lie with the public sector whose primary objective is to provide information as a public good. Though there will continue to be public sector management and supervision of a private-sector contractor, the new system manager should have additional autonomy compared with the Traveler Information Center operation's contractor during the Field Operational Test. In addition, with a single contractor responsible for the operation and maintenance of the existing TravInfo system and the design, implementation, operation, and maintenance of enhancements to TravInfo's Traveler Information Center rather than the multitude of individual contractors during the Field Operational Test, operations will be considerably more streamlined than before and should ultimately bear fruit as a result.

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## 1.0 INTRODUCTION

This report constitutes the final deliverable for PATH Project MOU 365 — “An Experiment in Privatizing the Operations of Regional Transportation Information Centers: How Well is it Working?” Several reports have been produced as interim deliverables for this project, and are listed here as well as cited in the remainder of this Final Report where appropriate:

1. Miller, Mark and Dimitri Loukakos, “TravInfo Evaluation (Technology Element) Traveler Information Center (TIC) Study (September 1996 – June 1997)”, California PATH Working Paper, UCB-ITS-PWP-98-7, University of California, Berkeley, March 1998.
2. Miller, Mark and Dimitri Loukakos, “TravInfo Evaluation (Technology Element) Traveler Information Center (TIC) Study: *System Reliability and Communications Interface (9/96 – 12/97)*”, California PATH Working Paper, UCB-ITS-PWP-98-21, University of California, Berkeley, September 1998.
3. Miller, Mark and Dimitri Loukakos, “TravInfo Evaluation (Technology Element) Traveler Information Center (TIC) Study: *Operator Interface Analysis-Phase III*”, California PATH Working Paper, UCB-ITS-PWP-98-22, University of California, Berkeley, September 1998.
4. Miller, Mark and Dimitri Loukakos, “TravInfo Evaluation (Technology Element) Traveler Information Center (TIC) Study: *Operator Interface Component-Phase IV: Institutional Analysis*”, California PATH Working Paper, UCB-ITS-PWP-98-30, University of California, Berkeley, November 1998.
5. Miller, Mark and Dimitri Loukakos, “TravInfo Evaluation (Technology Element) Traveler Information Center (TIC) Study: Response Time Analysis”, California PATH Working Paper, UCB-ITS-PWP-2000-9, University of California, Berkeley, August 2000.

The project examined the operations of regional transportation information centers by 1. conducting a site-specific case study performance assessment of TravInfo’s regional traveler information center in the context of the evaluation of TravInfo’s Field Operational Test and 2. investigating traveler information centers in operation around the U.S. The remainder of this section discusses the objectives of and the methodological approach used in the project.

TravInfo is an advanced traveler information system for the San Francisco Bay Area that began operation in September 1996 under a public/private partnership seeking to compile, integrate, and broadly disseminate timely and accurate multi-modal traveler information through commercial products and services. The public sector component centers on the Traveler Information Center (TIC), TravInfo's information gathering, processing, and dissemination hub. For two years, until September 1998, it was a Field Operational Test (FOT) sponsored by the Federal Highway Administration. Since the end of the test TravInfo has been in a transitional or "as-is" phase continuing its operation without major changes to the TIC relative to the test phase. September 2000 is the tentative date when a new system manager for the TIC is expected to assume its managerial and operational responsibilities. At this time, TravInfo will progress to a more stable and likely permanent place as part of the Bay Area's information technology infrastructure.

The evaluation of TravInfo consisted of three major elements: (1) institutional, (2) technology, and (3) traveler response. The technology element consisted primarily of an assessment of the Traveler Information Center and consisted of a technical and an institutional analysis. The technical analysis included an examination of: system reliability, the communications interface, the operator work setting, and operator performance. System reliability examined system problems. The communications interface examined TIC data access on the part of both the public and private sectors. The operator work setting investigated the human element by considering the role of the operator in the flow of information through the TIC, operators' workload, system support of the operators, and the operators' physical working environment. Operator performance was investigated with respect to operator response time as measured by the operators' processing time for incidents between entry into the TIC and dissemination to the public and private sector. TravInfo operations were considerably less automated than originally envisioned and more dependent on operator performance and so operator response time took on added significance. The institutional analysis examined the TIC's operational effectiveness from the perspective of the institutional relationships among its public and private sector

participants as well as consideration of the deployment of Traveler Information Centers in other regions of the U.S.

## **2.0 PRE-OPERATIONAL DESIGN AND DEVELOPMENT HISTORY**

From approximately October 1992, when TravInfo was selected as a federally funded field operational test, through September 1996, when TravInfo officially began operations as a Field Operational Test, TravInfo's Traveler Information Center was designed, fully developed, and tested. During this four-year period, numerous events occurred, though while primarily of an institutional nature, also impacted field-test operations. They are described below.

### **2.1 Public and Private Sector Roles and Responsibilities**

Both the public and private sectors played major roles within the TravInfo Field Operational Test setting. There were public sector organizations representing the three regional transportation agencies in the San Francisco Bay Area — the Metropolitan Transportation Commission (the region's Metropolitan Planning Organization), Caltrans' District 4, and the California Highway Patrol's Golden Gate Division. Within the TravInfo setting, committees and other groups were established to assure both a public and private sector voice in the running of TravInfo.

In the summer of 1993, a private-sector consultant was retained to design and develop the system that was to become TravInfo's Traveler Information Center. The end of 1993 marked a change in the institutional relationship between TravInfo's public and private participants. The private partners were concerned that TravInfo could become a business competitor rather than give the private sector more business opportunities if TravInfo processed data to the point where private companies could add little value and then made the data widely available through the wireless data broadcasting system, direct modem links to individuals and a personalized automated phone reporting system. As a result, TravInfo management removed the wireless system from the TravInfo design and agreed to provide transportation data directly to the public only through the Traveler Advisory Telephone System's voice processing system publicly accessed via the 817-1717

telephone number. This agreement was an essential feature of the TravInfo field test intended to allow the private-sector participants to develop products without concerns over public-sector competition. This decision affected TIC operations by restricting the means through which it would communicate with the outside world to just TATS and the LDS.

## **2.2 Development and Use of Traffic Operations System Data**

TravInfo's original plan was to integrate traffic surveillance data from Caltrans' Traffic Operations System into the Traveler Information Center's database. The Traffic Operations System's data generated from inductive loop detectors were to be the major data source for TravInfo. Under development since 1990, the Traffic Operations System was expected to be fully operational and able to support TravInfo by the end of 1994. In October of that year, in response to problems with a computer system at the Department of Motor Vehicles, a California state executive order was issued to temporarily prohibit sole-source contracts for computer-system development throughout state government, which put a halt to further development of the Traffic Operations System (6).

This executive order had a major impact on TravInfo by significantly delaying its schedule. Over the longer term, the order led to TravInfo management to work with an already deployed system of inductive loop detectors covering only one-half of the originally envisioned number of freeway miles. To wait for the full-scale surveillance system to be deployed would have pushed the start of the field test beyond a date acceptable to the Federal Highway Administration, the sponsor. Caltrans agreed to transfer to the Metropolitan Transportation Commission the funds that were to have been used to build the full-scale Traffic Operations System. The Commission, as TravInfo's lead agency, agreed to develop an Interim Freeway Surveillance System, as the reduced Traffic Operations System was known, which it would eventually turn over to Caltrans for maintenance and operation. (This was done in early 1996.)

The interim system processed inductive loop data from field devices and put them in a format that could be entered into the TravInfo database. Inductive loop data are

automatically fed into the TIC without operator interpretation or processing. This delay and subsequent use of the interim system impacted TIC operations by increasing the reliance on data sources other than the inductive loop data, especially the Computer-Aided Dispatch incident reports from the California Highway Patrol. These reports, however, required significant interpretation and follow-up by the operators. Thus this delay and subsequent use of the interim system impacted TIC operations by ultimately leading to an overall increase in operator workload to process data from other sources and an added burden on an already heavily manual-dependent system.

### **2.3 System Design Issues**

In April 1996, TIC acceptance testing began even before TravInfo management approved a formal test plan. During testing, TravInfo management realized that the TIC's system did not meet project specifications. Instead of the system being automated, it was dependent primarily on manual operation. This affected TIC operations by placing significantly more weight on operator performance than anticipated which in turn led to changes in the direction of the evaluation. Despite evidence of significant problems with the system, the consultant requested on-the-spot acceptance, which coupled with TravInfo management resistance, led to protracted negotiations between the two sides. Over a year later than anticipated, TravInfo management granted conditional acceptance for the system, though acceptance testing continued for three months after start of the field test in September 1996. This delay also affected TIC operations by delaying the implementation of operator quality control and performance monitoring measures by assigning them a lower priority than other operational matters, such as completing acceptance testing.

These setbacks placed the project 28 months behind the proposed date for the start of baseline operations. Design and implementation lasted 35 months, 19 months longer than originally proposed to the Federal Highway Administration.

### **3.0 TIC SERVICE ATTRIBUTES AND STUDY METHODOLOGY**

The Traveler Information Center study assessed the state of TravInfo's technology in terms of its ability to collect, integrate, and broadly disseminate accurate, timely, and reliable traveler information throughout the Bay Area. This section describes the objectives of the TIC study, the TIC's service attributes, and the methodologies employed by its various elements.

The primary objective consisted of evaluating the operational effectiveness of the Traveler Information Center by gaining an understanding of

- TIC reliability over the course of the Field Operational Test
- Communication between the TIC and members of the public and private sectors
- The relationship between the operator and his/her working environment, and the degree of support that the TIC's computer interface design and the physical working environment afford to the operator in performing his/her job
- Operator performance
- Differences between the public and private roles for TIC operations and management

#### **3.1 Service Attributes**

The regional Traveler Information Center was the key component of the TravInfo field test. It is a publicly operated, centralized database that collects, processes, and disseminates traveler information throughout the nine-county Bay Area region.

Its data sources are the California Highway Patrol's Computer-Aided Dispatch system and the Freeway Service Patrol (The Bay Area Freeway Service Patrol is a joint project of the Metropolitan Transportation Commission), both of which supply data about incidents on freeways, airborne reports from the private contractor that operates the Traveler Information Center and its Web-based service, closed-circuit television cameras, callers from cellular phones, Caltrans (for road work updates and inductive loop sensors from the Traffic Operations System), beat calls to other sources (bridges, transit service providers, police stations, and county offices of public information), and the Transportation Management Center. In general, local agency data are not yet integrated into the Traveler Information Center's database, with the exceptions of some cities in Santa Clara County as well as the Santa Clara County Transportation Management

Center. Other cities are expected to eventually integrate their data into the system in a process that has continued since the conclusion of the field test. The CHP CAD is the number one data source used by operators at the TIC in terms of time spent on processing (3).

The public has access to Traveler Information Center data through the interactive Traveler Advisory Telephone System, which is a landline telephone network that can be reached by dialing 817-1717. Information service providers that registered to participate in the field test can tap into the center's database through a modem or telnet connection to TravInfo's landline data server.

The telephone advisory line provides public transit<sup>1</sup>, paratransit, and park-and-ride lot information; information on current traffic conditions (slowdowns, roadwork, incidents); carpooling, vanpooling, and commuter check information<sup>2</sup>; highway construction updates; and parking, bicycle, and airport ground transportation information. It also makes available a public comment line. It uses a touch-tone keypad, menu-driven interface, and an interface for travelers using a Teletype Terminal for the Deaf (TDD).

Of particular note is the information TravInfo provides during emergencies, roadway construction, and special events. During two travel-related emergency periods, the especially heavy rains of the winter of 1998, when severe flooding occurred, and the Bay Area Rapid Transit (BART) strike in September 1997, TravInfo disseminated travel warnings and advised on alternative travel options. When major highway projects were scheduled, such as the demolition of the Central Freeway in San Francisco, TravInfo advised motorists on street closures and alternate routes around the massive demolition zone. During the end-of-year holiday season, TravInfo reported airport parking information and traffic conditions around the three Bay Area international airports. During the summer, when ozone levels exceeded acceptable levels, TravInfo carried Spare-the-Air messages, sponsored by the Bay Area Air Quality Management District's clean air campaign. TravInfo advised callers of alternative modes of transportation, such as transit, to reduce emissions and improve air quality.

Current traffic updates and information on parking and bicycles are tailored to five sub-regions - the East Bay, South Bay, San Francisco, North Bay and Solano County, and the Peninsula - and the Bay Area's bridges. At the start of the field test, TravInfo was configured to the Bay Area's four area codes so that callers anywhere in the region could dial TravInfo with the same seven digits, without entering an area code. During the field test, two of the four codes split, and callers in regions defined by the new area codes temporarily had to dial the area code before the TravInfo access number, until TravInfo was able to institute corrective measures due to regularity constraints of the California Public Utilities Commission.

The Metropolitan Transportation Commission retained a private contractor to run the TravInfo Traveler Information Center, bringing its experience as a traffic-reporting business to the project. In TravInfo's early development phase, it was expected that the Traveler Information Center's operation would be considerably more automated than it ultimately turned out to be. Because of that, the performance of the operators and the interface between operators and the Traveler Information Center system played a more significant role in the center's operational effectiveness than anticipated. In recognition of that shift, the study examined in greater depth than originally intended the tasks and responsibilities of the operators, how quickly they executed them and the degree to which the working environment, including the computer interface that was employed, supported them.

### **3.2 Technical Analysis Element**

This section describes the four primary ways in which the Traveler Information Center was evaluated from a technical standpoint. The technical analysis component was divided into the following parts: system reliability, communications interface, operators' work setting, and operator performance. System reliability examined system problems. The communications interface examined TIC data access on the part of both the public and private sectors. The operator work setting investigated the human element by considering the role of the operator in the flow of information through the TIC, the operators' tasks and

responsibilities and the operators' physical working environment. Operator performance focused on operator response times and measured the time required by operators to process incident information entering the TIC to their eventual dissemination to the public and private sector.

### **3.2.1 System Reliability**

The TIC is the vehicle through which information is delivered to the public via TATS and to members of participating private sector information service providers (ISPs) via LDS. The objective of the system reliability element of the TIC evaluation was to analyze the problems that the TIC experienced over the course of the FOT in terms of their type and changes in the volume and types of problems over time with respect to particular measures of effectiveness, such as duration. For the assessment of system reliability, in collaboration with the TIC developer and its operations contractor, we developed a problem report template to be used by TIC operations staff upon occurrence of each TIC system problem, whether hardware- or software-related. Completed forms (hard copy) were obtained and entered into a TIC problem database for analysis.

### **3.2.2 Communications Interface**

The objective of the communications interface element of the TIC evaluation was to analyze the public's and the ISP's usage of the information provided by TravInfo. Specific areas of interest included the nature of calls into TATs with respect to their area of origin, duration, time period, call type, changes over time, and times during which the publicly accessible telephone ports for TATS use are simultaneously busy. Relative to ISP access of the LDS to download information, we were interested in learning about the specific data that ISP's were interested in and the frequency and volume of data downloaded by the ISPs. For the evaluation of the communications interface, an automated data collection process was designed and implemented to collect all information that was requested by callers of the Traveler Advisory Telephone System (TATS). This data was regularly downloaded via a telnet modem connection throughout the two-year FOT. A record of the data that members of the private sector accessed through the Landline Data Server (LDS) was stored (and archived) at the TIC. A copy of

this data set was transmitted to us via the FTP file transfer process regularly throughout the FOT.

### **3.2.3 Operator Work Setting**

The Traveler Information Center's performance depends in part on how its underlying system supported the operators in performing their jobs. Operators communicate with many people and work with a great deal of equipment and supplies in the course of performing their daily tasks. Operators work at both the Traveler Information Center computer and the California Highway Patrol Computer-Aided Dispatch terminal located at each operator's workstation; they monitor closed-circuit television screens and use a telephone, a voice-processing system, a printer and a fax. They fill out (paper) operator activity tracking forms; communicate with other operators, Traveler Information Center supervisors and management, maintenance crew, and, to some extent, Traveler Information Center visitors; and take reports from the cellular reporter network.

The evaluation of the operator work setting was accomplished by 1. performing on-site visits to the TIC to observe the operator interface and 2. designing and administering a questionnaire to TIC operators concerning aspects of the operator interface and their physical working environment. The primary operator interface is with the Traveler Information Center computers and the center's databases. The Traveler Information Center-operator interface structure is a proprietary software product of the system developer running on a Sun Workstation with a Solaris operating system supporting a Sybase database and the X-Windows/Motif graphical user interface. Each window consists of a frame, a toolbar of pull-down menu items, a resizing corner, a closure button, a full screen button, and an optional scroll bar. The Traveler Information Center-operator interface design utilizes a combination of three dialog styles or means of interaction, between the operator and the system: menus, fill-in forms and direct manipulation. A menu provides a list of options from which an operator makes selections. A fill-in form is an electronic version of a paper fill-in form, i.e., structured and formatted with fields in which an operator enters data. In direct manipulation, operators perform actions directly on visible objects instead of specifying actions

indirectly through language. These interfaces are sometimes called “point-and-select” interfaces and include a pointing device such as a mouse and often use graphics to display objects and actions.

The operator interface evaluation was conducted through examination of the interface by the evaluators and operator interviews. The TIC operator interface design evaluation has three components: 1. understanding the operator interface design features, 2. describing the objectives of the user interface design and measuring the extent to which they are satisfied, and 3. determining operator profile characteristics and their relationship with the interface design. Among the objectives of operator interface design are: compatibility with the needs of the operator, consistency, familiarity, simplicity, and ease of learning and use. The operator compatibility objective refers to the designer’s need to know the operator and be able to construct an interface compatible with the operator’s job-related needs. The operators were surveyed to develop such a profile.

Another part of the evaluation consisted of an assessment of the operator’s working environment, at the workstation and the surrounding environment, based on a survey of operators and evaluator visits to the TIC. The objective of this work was to understand the level of operator acceptability with the different aspects of the TIC working environment. The working environment may contribute to or hinder the operator’s ability to do his/her job efficiently and effectively. A checklist of key working environment characteristics was used to help identify those that may contribute to or hinder the TIC operator’s job performance. These key considerations include characteristics of the ambient air, noise, and light, and the attributes of the computer screens and keyboards and work surfaces and furniture. For most of the field test, operators worked in a single room in individually enclosed workstations separated by height-adjustable partitions. Three months before the field test ended, the operations moved to a new location, which was smaller but allowed in natural light.

### **3.2.4 Operator Performance**

Operator performance was measured through operator response time to process incident information through the TIC. Data was collected from multiple sources, both electronic and hard copy, for information specific to the timing of particular events, such as the arrival of incident information at the TIC, the completion of TIC operator incident processing, and the input of processed information into the TATS voice processing system for dissemination to the public.

One of TravInfo's primary goals has been to provide timely traveler information, but there is no unambiguous and generally accepted meaning of "timely" in this context. It was stated during the design and development of the TIC, that on average no more than one minute should elapse between the receipt of information about a freeway incident and its being posted on the server and the telephone advisory line (1). That, however, does not take into account the time between the incident's happening and the center first being aware of it<sup>3</sup>. Thus, "timely" does not necessarily mean "instantaneously."

Moreover, with the California Highway Patrol Computer-Aided Dispatch system being the primary Traveler Information Center data source, and its data needing to be manually entered, which creates a potentially serious bottleneck in Traveler Information Center information flow, to enter, process and disseminate such data would very likely require longer than one minute.

The operator's response time is critical to how well the center meets this ambiguous goal. However, with no baseline value for what a "timely" response is, the timeliness of operators' responses could not be comparatively assessed. Factors that could influence them, however, were identified, the added time associated with these factors was calculated, and recommendations were made for altering certain factors in order to reduce times.

Two one-week, i.e., the work week—Monday through Friday, analyses approximately six months apart were conducted during the final nine months of the field test. Response times were examined between 5 a.m. and 8 p.m. for each day of these two weeks.

Response time was defined as the time between an incident first being posted on the California Highway Patrol's Computer-Aided Dispatch system and it being entered into the phone system and available to the public.

There are some notable intermediate times, like the moments between an incident being posted and an operator being aware of its posting and the gap between an operator's initial awareness of a posting and its verification. The time between the first appearance of an incident record in the California Highway Patrol's Computer-Aided Dispatch system and operator awareness of it depends mainly on the operator's workload and attentiveness. Operators are instructed to confirm an incident before entering it into the database, and while they make attempts to do this, actual verification does not always occur before an entry is made in the interest of remaining timely, according to operators. Operators use several means to confirm an incident, including an on-site California Highway Patrol officer report, an airborne record, a web-service report, multiple Computer-Aided Dispatch entries for the same incident, and operators' experience about incidents occurring at certain locations during certain time periods.

The time between the first appearance of an incident record in the California Highway Patrol's Computer-Aided Dispatch system and incident verification (if it actually occurs) is a time in which operators are engaged in making incident verification attempts for that particular incident, as well as other activities related to other incidents and other Traveler Information Center operational matters. The time between incident verification (again, if it occurs) and entering the processed incident into the Traveler Information Center is related more to the specific incident under examination.

The following factors could potentially influence operator response times: the number of incidents to be processed; the rate at which incidents arrive, the type of incident (e.g., traffic hazard, accident with major injuries), the time of day, the location where the incident is processed (i.e., the specific geographic workstation), the length of the operator's experience working at the Traveler Information Center, the time and nature of the California Highway Patrol's Computer-Aided Dispatch system problems

(documented by operators), the time and nature of the Traveler Information Center's system problems (documented by operators), operators' work-break periods, and weather conditions.

### **3.3 Institutional Analysis Element**

The technical analysis element is one of two primary components of assessing the operational effectiveness of the TravInfo Traveler Information Center. The second component is the institutional analysis element, including the identification of both areas of achievement as well as barriers to successful TIC operations. For the institutional analysis element, literature searches were conducted, and members of the TIC staff and TravInfo management were interviewed to solicit their opinions and insight into institutional-related issues of TIC operations.

The Traveler Information Center consisted of a four-tier hierarchy of program manager, operations manager, supervisors, and operators. The evaluation was conducted through an analysis of responses to questions during in-person interviews of TIC operators, supervisors, and management. Other TravInfo management personnel were also included in this institutional assessment, since even though the TIC's day-to-day operations were directed and managed by its private-sector contractor, overall management decision-making came from TravInfo management. The survey focused on the following areas:

- TIC operational goals
- Areas of achievement
- Areas of concern/barriers to achievement
- Perceptions of TIC operations
- Organizational structure and partnerships

The institutional analysis element was also examined in the larger context of regional Traveler Information Centers in use around the U.S.

## **4.0 STUDY FINDINGS**

This section discusses the study findings of our evaluation, which consists of technical and institutional analysis elements. The technical analysis component was divided into the following parts: system reliability, communications interface, operator work setting, and operator response times. The institutional analysis component examined how the Traveler Information Center operated and was managed with a special emphasis on the public/private aspects.

### **4.1 Technical Analysis Element**

This section presents the findings from the technical analysis component of the Traveler Information Center evaluation. First we discuss system reliability, followed by the communications interface, then the operator work setting and finally operator performance.

#### **4.1.1 System Reliability**

Only a very limited assessment of TIC system reliability was conducted during the two-year Field Operational Test because several issues arose that posed serious challenges to performing the quantitative assessment proposed in the TIC evaluation plan (2). We present a summary of events during the FOT that affected the course of the system reliability assessment, discuss the issues that arose, and lastly present the more qualitative system reliability findings.

The Traveler Information Center became operational in September 1996. The evaluation plan called for data to be collected concerning each TIC problem and then entered into a TIC problem database for analysis. Data included problem location (functional, physical, logical), symptom(s), severity, cause(s), impact(s), action(s) taken, date, and time-of-day. Data was to have been collected by TIC operators and their supervisors by filling out a TIC Problem Report Form designed with fields corresponding to the specific data types listed above. Not all data would be provided by TIC operators, e.g., cause(s) or action(s), but instead would be provided by the TIC system-developer consultant, who, upon receiving the partially completed forms, would be resolving the problems. One issue was

a time delay until a single TIC Problem Report Form was designed and put into use that could satisfy the different needs of the three major TIC players: its developer, operational staff, and evaluator. In addition, the form had to be acceptable to TravInfo management. The start date for implementation of the new form was January 1997.

A TIC evaluation interim report covering the period between September 1996 and June 1997 included a section on system reliability for the January to June 1997 time period (3). A second interim report covering the cumulative time period between September 1996 to December 1997 focused on the July to December 1997 period and included a discussion of system reliability for this latter period (4). However, beginning in July 1997 TIC operational staff documented only non-recurring problems. From January to June 1997 all TIC problems, non-recurring as well as recurring, were documented. The evaluators were not informed of this significant procedural change until April 1998. Because of this change, system reliability could not be analyzed in a complete and consistent fashion throughout the FOT and precluded a valid comparison of the findings for the July to December 1997 period with the January to June 1997 period. It was decided that for the remaining months of the FOT, i.e., May to September 1998, TIC operational staff would resume documenting all TIC problems so as to facilitate a valid comparison of TIC system reliability over at least a portion of the two-year FOT: January 1997 to June 1997 compared with May 1998 to September 1998.

However, even this limited system reliability assessment—*early* FOT compared with *late* FOT—faced challenges. Of all issues affecting the assessment of system reliability, probably the most significant was the fact that a maintenance contract between TravInfo management and the TIC system-developer consultant was not signed until November 1997, a year and two months after TIC operations began and more than half way through the FOT period. The signing of the maintenance contract allowed a technical support person on contract to the system developer to work at the TIC but not until four months later in March 1998 (5). Thus, the time it took to reach these contractual agreements and bring a system administrator on board contributed to significant delays in obtaining technical support. Until this contract was signed, TIC problem reports were generally not

forwarded onto the system developer since only system-critical problems were addressed. TIC operations were thus not provided regular and sustained system maintenance support until the Field Operational Test was nearly three-quarters complete and this contributed to operator frustration and a questioning of the value and priority of reporting each and every problem especially relative to more pressing operational concerns. This led to an understandable under reporting of recurring TIC problems, especially the relatively minor ones. Also, operational needs sometimes differed from and took precedence over evaluation needs and this affected the reporting of TIC problems. This helps explain why the TIC problem reporting procedure was officially changed in July 1997 to omit the reporting of recurring problems.

Another challenge that contributed to questioning the validity of the comparison of TIC problems between *early* and *late* in the FOT, concerned individual operator judgment inherent in and necessary for filling out of the TIC Problem Reports. An especially important piece of information on the form was problem severity to be categorized as “minor”, “major”, or “critical”. TIC operations staff developed definitions for these terms in discussions with the evaluators, however, these definitions were not stated in absolutely and unambiguously quantifiable terms. Thus, while operators received the same training, they still had the latitude to potentially interpret these terms differently, i.e., one operator’s “minor” problem could be another operator’s “major” problem. While TIC supervisors did provide a check on how operators filled out the problem reports, it wasn’t until the second half of the FOT that a single and consistently applied review was made of all TIC problem reports by TIC operations management before being distributed.

During the January to June 1997 period there were 73 internal TIC problems, i.e., problems originating inside the TIC environment as opposed to outside such as TOS, FSP, or CAD-related problems. In both cases the overwhelming majority of problems were located in the TIC’s processing functional subsystem. For the earlier period, approximately 70% of the problems were classified as “major”, while during the later period, problems were approximately evenly distributed among all three problem-severity classifications. During the May to September 1998 period, there were 47 internal TIC

problems. Since the later period is shorter than the first, we would expect a smaller number of problems in the later period. Adjusting for this difference in the number of days as a reason for the decrease in the number of problems gives approximately 62 as the revised number of problems in the January to June 1997 period. Comparing 47 with 62 indicates that there has been a reduction in the number of internal TIC problems by approximately 24%. It is very likely that the signing of the maintenance contract, having an in-house system administrator, a single reviewer of all TIC problems prior to their being finalized, and improved stability of the TIC associated with the passage of time have significantly contributed to this reduction in TIC problems.

#### **4.1.2 Communications Interface**

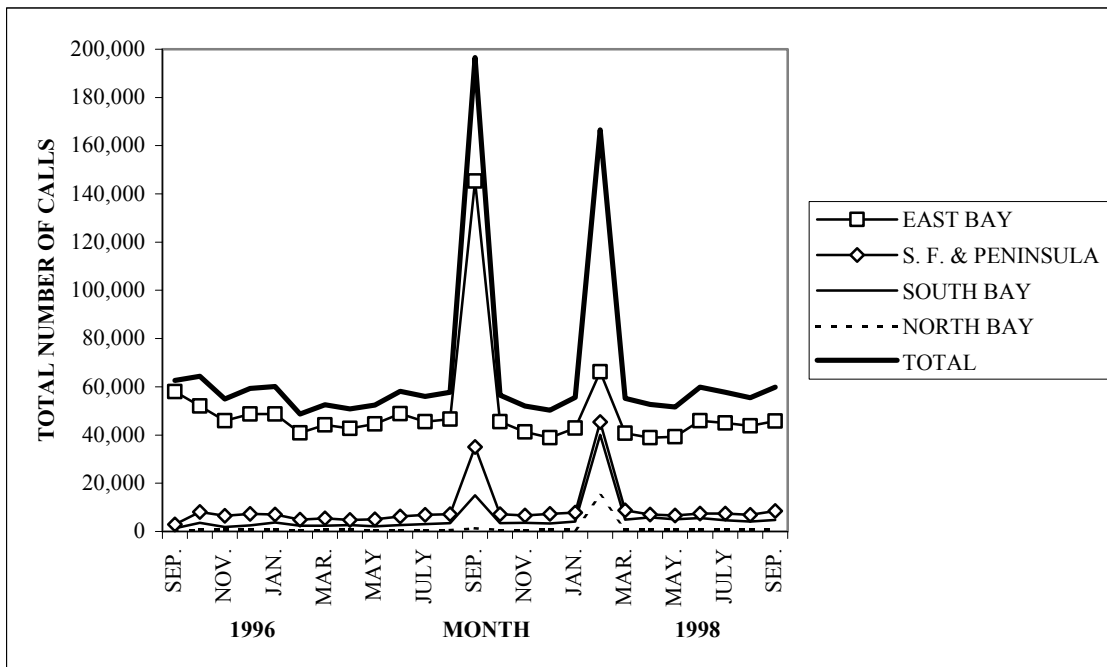
TATS call volume statistics remained quite stable throughout the two-year test period with the notable exception of two external events. Monthly call volumes to the traveler advisory telephone line ranged between approximately 50,000 and 65,000, with an average of 55,000 calls (or about 1,800 calls a day). Transit information requests accounted for 60% to 70% of the total volume, and calls requesting traffic information ranged from 10% to 20%. Based on those volumes, it was estimated that the telephone line had approximately 1,500 traffic information callers per month. Approximately 10% of calls were for other transportation-related information such as bike trail and parking information. Alameda-Contra Costa Transit (AC Transit) accounted for 70% to 80% of the transit calls, because TravInfo's telephone number was its sole telephone information source during the field test. The other Bay Area transit agencies retained their own telephone numbers, though calls could be routed to their own operators from TravInfo. The monthly call volumes were consistent during the field test, except during the BART strike in September 1997 and the heavy winter flooding in February 1998 (3, 4).

Overall TATS call volumes are depicted in Figures 1 and 2. Figure 1 shows the two-year call volume distribution divided into the four major calling regions of the Bay Area. Figure 2 shows the same call volume totals divided by call type, primarily transit and traffic. On average with the exception of September 1997 (BART strike) and February 1998 (winter flooding), transit and traffic calls comprised approximately 62% and 16% of

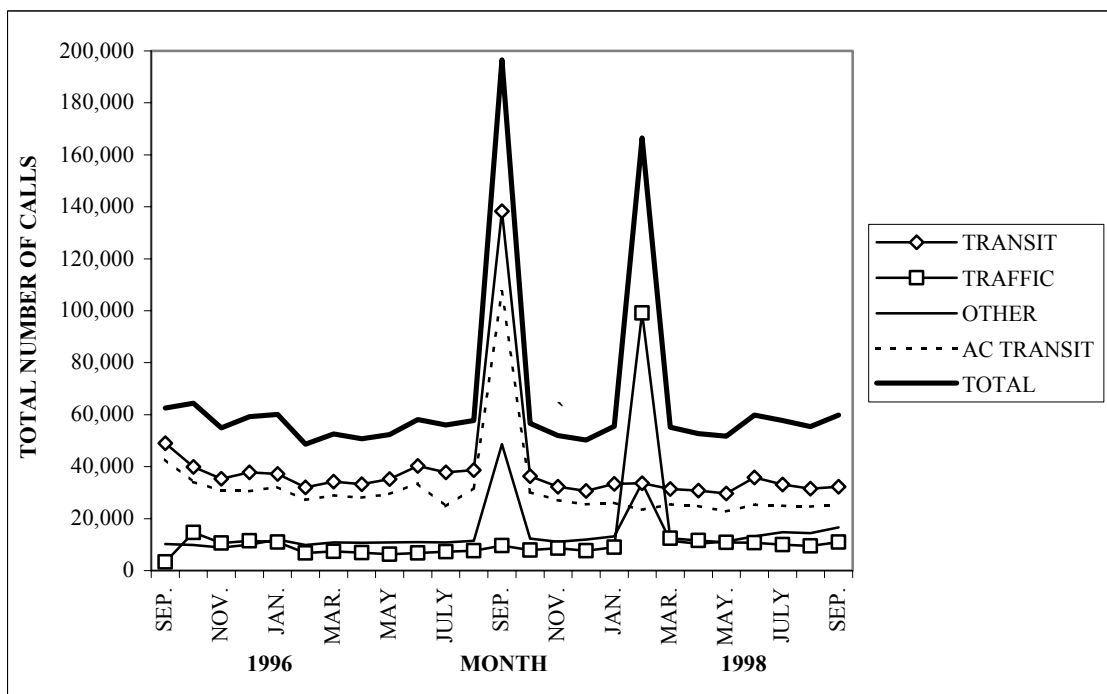
all calls, respectively. Again, with the exception of these two months with extraordinary events, calls for AC Transit comprised approximately 81% of all transit calls and 51% of all calls. These call volumes for AC Transit combined with the fact that it is located in the East Bay are dramatically shown in Figure 1 with respect to the importance of call volume from the East Bay region relative to the other regions.

Figures 1 and 2 show the enormous spikes in call volumes during the BART strike and winter flooding yet within one to two weeks call volumes returned to their pre-event levels. During the eight-day BART strike, daily call volumes reached a maximum of 8,500. These calls were primarily made by people seeking information about the availability of alternative transit services. During the heaviest winter flooding, a two-week period, 8,000 calls were made daily at the peak. Most of the people calling sought information about road or traffic conditions. During the BART strike, 70% of all calls concerned transit questions, and during the floods, 70% were traffic-related. The TravInfo telephone information service was mentioned and endorsed by both television and radio stations during the events. TravInfo was referred to as a transit hotline during the BART strike and as a traffic hotline during the flood period. Neither of these events had significant long-term effects on increasing call volumes.

**Figure 1: Regional and Total Monthly Call Volumes**



**Figure 2: Total Monthly Call Volumes by Call Type**



To tap into the TravInfo database, information service providers, public agencies, or research organizations had to register with TravInfo. By the end of the field test, registered participants reached over 50. Of that group, 90% were in the private sector. They ranged from small local Bay Area firms to large international corporations.

Approximately 30 of the private firms retrieved TravInfo data intermittently. Etak, DaimlerChrysler, and Maxwell were continuous users throughout the field test, and *The Contra Costa Times* began retrieving data approximately six months after operations began and has continued to do so. Etak, Maxwell, and *The Contra Costa Times* deployed Internet Web sites that provide traffic information using TravInfo data either exclusively or partly and get access to the TravInfo database every day, 24 hours a day, every two to three minutes at times, and often continuously. Etak downloaded approximately 90% of the TravInfo data, with the other three firms downloading approximately 8 to 9%. In addition, two public agencies developed kiosk systems that will include TravInfo data, e.g., Contra Costa County's TRANSPAC and the City of Alameda. DaimlerChrysler, Fastline, Digital DJ, Etak, and others are in various stages of developing other products. For example, Fastline is about to deploy its service via a personal digital assistant using the TravInfo database exclusively, and Etak has developed an information service via cellular phone (3, 4).

These companies were interested in developing advanced traveler information system technologies through the use of:

- wireless services such as cellular phones, FM subcarriers, and paging;
- in-vehicle navigation devices, real-time traffic information systems, and roadside assistance programs;
- portable and hand-held PCs and personal digital assistants;
- personalized profiling paging and alerting services;
- Web pages, Internet-based personalized profiling and alerting services;
- interactive broadcast and cable TV;
- conventional cable TV;

- fleet-management systems;
- telephone-based information services;
- and kiosks.

#### **4.1.3 Operator Work Setting**

This section presents the findings of the evaluation of the operator work setting. This consists of overall operator workload, the system support of the operators, and the physical working environment.

##### **4.1.3.1 Operator Workload**

The Traveler Information Center operates 24 hours a day, 7 days a week. There are three weekday shifts (5 a.m. to 1 p.m., 1 p.m. to 9 p.m. and 9 p.m. to 5 a.m.) with the busier morning and afternoon shifts each staffed by four operators and one supervisor and the overnight shift staffed by one operator. During weekends, there are rotating shifts with generally two operators on duty during the day and one overnight (3).

Operators must process information from all the sources listed above except for data from Caltrans' Traffic Operations System inductive loop sensors and the Freeway Service Patrol, which are automatically fed into the center without operator interpretation or processing. But because the loop sensors were not deployed as extensively as anticipated, coupled with their ongoing accuracy and communications-related problems, the most significant data source soon became the Computer-Aided Dispatch incident reports from the Highway Patrol, which required significant interpretation and follow-up by the operators.

After acquiring and integrating data from all these sources, the operators update the center's master database and then update the message on the telephone advisory line<sup>4</sup> for public dissemination. Operators can then also make changes in existing incident reports or events announcements as updates are received, and the new data are routed to the server that supplies the information service providers.

During the shifts that have rush hours, 5 a.m. to 1 p.m. and 1 p.m. to 9 p.m., three operators are assigned to specific geographic regions. A fourth covers traffic slowdowns and roadwork for the whole Bay Area. Slowdown information, i.e., recurring congestion, is covered mainly during rush hours while mostly roadwork data are entered the remainder of the time. During the overnight shift, the operator covers mainly incidents and enters roadwork data.

The Computer-Aided Dispatch data present the greatest potential bottleneck in the flow of information because they must be manually entered into the Traveler Information Center's system even though the source is an automated feed. Approximately seventy-five percent of each operator's time (except for the person in the slowdown position) is spent on this data, which represent about ninety percent of what arrives at the three geographic workstations. During inclement weather or particularly busy periods, a backlog may develop, requiring the operator to select only the more salient incidents.

#### **4.1.3.2 System Support of Operators**

Although the software, overall, allows operators to perform their tasks relatively efficiently, the interface could have been designed to better support them at their tasks. Its shortcomings included fill-in forms whose organization and layout did not always consider operator tasks; menus on the two most important and commonly used windows that were poorly ordered, filled with rarely used items and not ordered by frequency of use or by categories to assist the operator for timely retrieval of needed information, forms that failed to group related items or contained ambiguous terms; attributes within certain fields that were not mutually exclusive; and inconsistent organization in different windows. The operators have adapted to these design shortcomings, but there could be time delays resulting from them. Some changes have been made since the operator interface evaluation was conducted. In particular, rarely used items have been removed and ordering is now alphabetical (6).

These design weaknesses likely result in a loss of operator time. It is difficult to quantify this time loss because there is no readily identifiable baseline against which the present

system can be compared and it is difficult to break down the time loss into separate components one of which would be ascribed to poor interface design. While the operators have adapted and learned to circumvent some of the design shortcomings, nevertheless, there are likely still time delays. Design weaknesses have also caused a certain level of frustration among the operators and this is reflected in the relatively low overall rating of the interface design by the operators. On the positive side, the window system used is flexible and allows customization of the windows environment to suit the task at hand and/or operator preferences.

#### **4.1.3.3 Physical Working Environment**

There were only three characteristics where work environmental changes would lead to a more productive TIC working environment: 1. thermal and air quality, 2. general layout of work surface, and 3. cubicle height or sense of connectedness with other operators. Other characteristics were found to be generally acceptable to the operators (6).

#### **4.1.4 Operator Performance**

During the FOT, as reflected in the two-wave test, average response times for processing incidents from the Highway Patrol's Computer-Aided Dispatch system and disseminating the information to the public through the Traveler Advisory Telephone System remained stable with an average value of approximately 11 minutes. Approximately 20% of the total number of incoming Computer-Aided Dispatch incidents were entered. Operators' job performance and level of operator workload were the two primary factors influencing the number of incidents entered into the system and operator response times for those entered incidents. Other factors were also examined to assess their influence on operator response times, such as number and type of incidents (e.g., traffic hazard, accident with major injuries) reported by the California Highway Patrol, time of day, the location (Operator Work Station) where the incident was processed, i.e., the specific geographic workstation, level of operator work experience at the TIC, incident arrival rate, operator work-break periods, weather conditions, and system software and hardware problems (documented by operators). These factors, however, played only a minor role in influencing response times (7).

Numerous operator work activities also affect operator response times and help provide the fuller context within which response times were assessed. These activities included attempts to verify an incident, disruptions caused by their own and other operators' shift changes, operator call-checking into the phone advisory system for quality control purposes, updating an incident already entered into the system, searching for multiple listings for the same incident or those not delaying traffic flow. However, these activities were difficult to isolate and individually quantify their contribution to operator response times.

It is anticipated that once TravInfo enters its more permanent and stable phase with a new system manager, operations will soon become substantially more automated and this should have a significant impact on reducing operator response times as well as increasing overall operator productivity. It is recommended that once these changes are implemented, subsequent operator response time assessments be made. Automating operations coupled with the much stricter operator quality control measures that were put in place near the end of the FOT should combine to make operations more like the "timely" undertaking it was intended to be.

## **4.2 Institutional Analysis Element**

This section presents the findings from the institutional analysis element and consists of two subsections. First, the analysis of the interviews with members of the TIC's operational staff as well as members of TravInfo management is discussed (5). Secondly, we discuss the results of our examination of regional TICs.

### **4.2.1 TravInfo Operational Effectiveness: Institutional Perspective**

The commonly expressed TIC operational goal was to provide timely, complete, user friendly, and accurate information to the public and private sectors. Overwhelmingly, all survey respondents felt that the TIC was effective in achieving this operational goal, given the constraints and available resources. Indeed, while data was collected, processed, and disseminated to the public and private sectors, there were, nonetheless,

constraints to operational effectiveness most of which were out of TIC operations' control, i.e., the origins of these problems pre-dated the beginning of TIC operations. The primary constraints were: 1. uncertain availability of reliable and accurate automated data, 2. delays related to ongoing contractual issues between the Metropolitan Transportation Commission (MTC) and the system developer that impacted the timely implementation of system improvements and technical support, 3. a computer interface that inadequately met TIC operator's needs and responsibilities, and 4. a computer interface design with a lower level of automation than originally envisioned.

There were, nonetheless, problems impacting effectiveness that could have been addressed more completely and earlier by TIC operations. These problems were: 1. lack of operator quality control measures and performance monitoring until the FOT was three-quarters complete and 2. insufficiently frequent communication among the TIC staff on subjects ranging from post-FOT status of TravInfo to operator suggestions for improvements.

There were, however, also areas of success that contributed to operational effectiveness. Chief among these were: 1. quality of overall staff in terms of skills, attitude, and responsiveness to emergency conditions (BART strike, El Niño flood period), 2. inter-organizational cooperation, in particular, between Metro Networks and the Voice Processing System developer, and 3. quality of certain data sources, namely, the California Highway Patrol Computer Aided Dispatch (CHP CAD), Metro Networks Airborne, and Metro Networks Instatrack Web page.

In making recommendations for improving operational effectiveness, it is useful to consider separately the pre-operational and operational environments. During the former, detailed pre-project planning is essential, particularly vis-à-vis selection of a dedicated contractor(s), contractual agreements, data sources, and software interface design. During operations, key issues to consider include the hiring of staff with a high level of adaptability and flexibility to accommodate an ever-changing environment, instituting

staff quality control measures, and insuring a high level of communication among all staff.

#### **4.2.2 Examination of Regional Traveler Information Centers**

The traveler information dissemination sector has undergone major changes in recent years in the wake of the digital revolution and the explosion in communication technologies and devices. Few projects of a similar nature to TravInfo were actually in existence at the same time as TravInfo. These were the Los Angeles SmarTraveler and the Boston SmarTraveler. In recent years (1997-98 on) many SmartTraveler type projects have been deployed throughout the country under the leadership of SmartRoute Systems Inc. There were several other FOT's having to do with the dissemination of traveler information, such as the Atlanta Showcase, TravTek and ADVANCE, however these systems did not make information directly available to the general public and/or did not have an open architecture allowing any private company to use data and provide products and services which were crucial elements of TravInfo's deployment.

The private sector has been quite active in the provision of traveler information. Generally, private companies have focused on the provision of traffic information to radio and TV stations. The boom in Internet services has also brought about new dissemination mechanisms and revenue schemes.

##### **4.2.2.1 Field Operational Tests and Model Deployment Projects**

The Los Angeles Smart Traveler Field Operational Test was deployed between January 1994 and January 1995. It offered information on real-time traffic conditions, transit schedules and route planning, and ridesharing services via public kiosks, telephones, and PC-modem links. The test covered the Los Angeles Basin area affected by the Northridge earthquake: the San Fernando Valley, the Santa Clarita Valley, Palmdale, and West Los Angeles. The test was based on a public-private partnership among the following organizations: California Department of Transportation, the Los Angeles County Metropolitan Transportation Authority, the State of California Health and Welfare Data Center, Commuter Transportation Services, Inc., Pacific Bell and Pacific Bell

Information Services, IBM Corporation, and North Communications. Field test funding was provided by the State of California, through the California Advanced Public Transit System Program, and the Federal Highway Administration through earthquake relief funds. The Los Angeles SmartTraveler displayed a map of Los Angeles freeways, color-coded to indicate congestion level, based on real-time conditions. It also assisted with transit trip planning between any given origin/destination pair requested by a user. The service did not include real-time waiting times (8).

A second test was in the metropolitan Boston area. The Boston SmarTraveler was initially planned as a one-year operational test, but it has been in operation continuously since January 1993. The system provides real-time, route-specific traffic and transit information to travelers in the Boston, Massachusetts, Metropolitan Area. It is accessible only by telephone (via a toll-free number) within a 1,400 square mile service area, including two million drivers. The Federal Highway Administration and the Massachusetts Highway Department provided funding for the project, which was operated by SmartRoute Systems Inc. The project was a public-private partnership under the combined co-leadership of the Massachusetts Highway Department and SmartRoute Systems Inc. Total funding was approximately \$6 million through December 1994. Service is provided free of charge to the general public, excluding phone call costs. Starting in 1997-98, SmarTraveler projects have begun in most major U.S. cities. The Boston SmarTraveler provides route-specific information on 21 highway segments, including descriptions of travel conditions, travel times, and incident location and expected duration. Information is continuously updated on weekdays between 5:30 A.M. and 7:00 P.M., and 12:00 noon to 7:00 P.M. on Sundays. Users access information by entering a three-digit code, unique for each highway section or transit service (9).

A third area of regional traveler information centers focuses on the Metropolitan Model Deployment Initiative Projects and other Regional ATIS Projects. The Metropolitan Model Deployment Initiative (MMDI) program called for public and private sector partners to develop and integrate ITS technology to reduce travel times, improve safety, and provide enhanced travel information to the public. MMDI sites (Phoenix, San Antonio, Seattle, and New York/New Jersey) are characterized by a broad range of

projects, from traveler information Web pages to remote communications systems for ambulances. One of the results of these projects has been the creation of regional intermodal information dissemination systems. The best MMDI project in this respect is the Seattle Smart Trek (10 – 16).

Other regional ATIS projects that are worth investigating to obtain information on traveler information dissemination are: the Cincinnati/Northern Kentucky ARTIMIS, the Detroit MOTORCITI and the Minneapolis Orion and Guidestar projects.

#### **4.2.2.2 Private Providers of Information**

Traveler information is also provided by a number of private, for profit, companies. The industry has undergone some major changes in the last five years in the wake of the “digital revolution”. The information has been and continues to be predominantly traffic information provided on a regional level. Generally, the information was provided to radio and TV stations in exchange for airtime slots that were then sold to advertisers. This is still the case but with the recent explosion in media and communications devices (web, cellular, palm pilots, cable and satellite TV, soon in-vehicle satellite radio), information dissemination methods have multiplied and the traditional payment or revenue-generating schemes are also undergoing changes. Web-based information is generally supported by advertising on the providers’ page (SmarTraveler) or is licensed (Metro/Etak) to information or entertainment Web sites (such as Web radios or TVs, on-line newspapers etc). Information provision is also becoming more accurate, is increasingly personalized to users’ needs and targeted to specific markets. The three main new traveler information provision markets are the Internet, wireless devices (phone and palm pilots) and in-vehicle communications.

The industry for traffic information dissemination used to be dominated by two players Metro Networks and Shadow Broadcast Services. A third player, SmartRoute Systems also gained increasing market share in the last few years focusing more on the Internet and phone provision of information (regularly launching new traffic web sites across the country). In recent years, the traffic provision industry underwent major concentration

under the aegis of Westwood One, Inc. It acquired Shadow Broadcast Services in 1996, Metro Networks in 1999 (17) and is currently acquiring SmartRoute Systems (18).

#### **4.2.2.2.1 Traffic Information on the Internet**

Travelers in several U.S. metropolitan regions can now access real-time traffic information via numerous Web sites. Most of these sites have been designed in collaboration with local transportation authorities or nationwide traffic information providers. The information is usually displayed on a map, color-coded to identify network speeds, congestion levels, or incident locations. In addition, some of these sites include CCTV videos, updated as frequently as every few seconds, but more commonly every few minutes (12).

Internet sites provide a wealth of information: congestion, speed, and incident location maps, detailed incident information, mountain pass reports and current conditions, freeway photographs, transit routes and schedules, current and forecasted weather conditions, road construction updates, and sometimes even trip planning tools.

Web-based traveler information dissemination has developed very rapidly in the last few years along with the boom in all Internet services. This appears to be a particularly attractive way to rapidly disseminate pre-trip traveler information. It will also fast become an important means of en-route traveler information and dynamic route guidance as cars and cell phones are increasingly equipped with Internet connections.

The following are a few examples of Internet traveler information sites:

- [Smart Trek](#): Up-to-the minute multimodal traveler information provided by the Washington State Department of Transportation (project leader) and 24 private and public organizations.
- [Metro Networks and Etak](#): Etak Inc. is a publisher and provider of digital mapping technology. Metro Networks is provider of traffic information and news. Etak, in partnership with Metro Networks, provides real-time information for 65

metropolitan areas. Both were private partners in the San Francisco Bay Area's TravInfo field operational test.

- [SmarTraveler](#): Offers real-time traffic information as well as other multimodal information (transit, carpooling, parking etc.) for 18 major cities.

### **4.3 Accomplishments**

This section presents accomplishments associated with the Traveler Information Center operations.

#### Recruitment and hiring of TIC staff

The effectiveness of Traveler Information Center operations depends to a large degree on its staff because of the manual nature of Traveler Information Center operations. While there were operator performance issues during the early part of the field test due to inadequate quality-control measures, these measures were implemented near the end of the field test. Subsequently, continuous enhancements have been made to these quality-control measures, including additional supervision during non-peak hours, e.g., weekends. Overall, good hiring decisions were made, competent staff was employed, and management oversight was implemented.

#### Work habits of staff

Operations staff exhibited teamwork and resourcefulness among themselves, as well as cooperation with and responsiveness to the Management Board during the field test. Staff showed flexibility and resourcefulness in integrating new data to augment Caltrans' Traffic Operation System loop data after they were found wanting and developing additional data-entry tools (e.g., macros for use on the California Highway Patrol's Computer-Aided Dispatch terminal). They also rose to the occasion in maintaining the center during emergencies such as floods and the BART system strike. Overall, the staff showed initiative, flexibility, and teamwork.

#### Relationship between TIC staff and contractors

Collaboration of staff with other project contractors contributed to a more efficient operation, as did both teams' commitment to solving problems as they occurred.

#### **4.4 Challenges**

Despite these accomplishments, the operation of the Traveler Information Center also encountered challenges over the course of the TravInfo Field Operational Test. These challenges are:

##### Impact of data availability on operator performance

There were shortcomings in traffic data and this impeded operator performance. Because of the inadequate data coverage from the Traffic Operation System's loop network, the Traveler Information Center performed under significant constraints. It required TravInfo to rely on other sources such as closed circuit television and cellular calls, which resulted in an increase in operator work load and in considerably less scope of coverage for the Traveler Information Center, and prevented TravInfo from providing highway speed and congestion information to the public and to private-sector partners reliably and accurately.

##### Manual nature of TIC operations

The greater-than-expected reliance on human operators made the database less timely and complete. Relying on operators to perform data-entry and dissemination tasks proved time-consuming and labor-intensive, especially in the transfer of incidents from the California Highway Patrol's Computer-Aided Dispatch system's terminal to the Traveler Information Center's system and from the Traveler Information Center's system to the telephone advisory system. Although it is very likely that operators would still need to intervene in the selection of incidents, automating the entry process could speed operators' responses and increase the number of incidents they could process. However, the operators' intervention is still crucial to the execution of many essential functions such as carrying out general system maintenance, circumventing design shortcomings and verifying and tracking data.

#### Lack of sufficient system support for operators

The design of the computer interface provided insufficient support for operators to perform their jobs. Although the team that designed the interface stated that it incorporated operators' needs from similar, earlier systems, the operators in the Traveler Information Center still had to make adaptations to compensate for design shortcomings. Overall, the resulting Traveler Information Center-operator interface provided insufficient support to the operations staff in the performance of their jobs. That likely contributed to longer response times.

### **5.0 LESSONS LEARNED**

The value of the field operational test and its evaluation is to identify and share the lessons learned with others that may be interested in developing and deploying similar projects in other regions. The lessons learned from the evaluation of the Traveler Information Center are described here.

#### Continuously changing technologies demand system flexibility.

While the original concept for TravInfo was open and flexible, TravInfo's final design was not. TravInfo will likely require enhancements, if not a complete replacement of its system, to keep up with advances in technology.

#### Data collection methods need streamlining.

The TravInfo system is complex. A number of problems can occur at any link in the chain, due to unforeseen institutional and technical obstacles. Streamlining the entire process, from fieldwork data collection to receipt of information by end users, would help eliminate some of them. For example, when the project team tried to fill some data coverage gaps with microwave radar devices, they encountered unanticipated difficulties in appending a new data stream onto the existing system.

#### Unforeseen events demand prior risk assessments and contingency planning policies.

A vital lesson learned from the data shortcoming is that a risk assessment of data reliability and contingency planning needed to be made early in the field test. The larger

issue, however, was the over-reliance on a separate project (leading to over-reliance on one data source) over which TravInfo had no control.

Another lesson was learned from attempting to accomplish the tasks set out in the original field test plan with the inefficient system design of the Traveler Information Center. The operator-dependent, manual system was not able to deliver the service as efficiently as the partners had anticipated if the automated system they expected had been in place. A contingency plan for dealing with a system which does not perform as specified would help the management team take necessary action, either allow enough time and resources to redesign the system or purchase a system that is more responsive to TravInfo's needs.

The TIC-operator interface should reflect operator characteristics, needs, and tasks.

The software interface should be designed either by directly involving intended users, in this case Traveler Information Center operators, in the design process, or by developing and utilizing a profile of user characteristics and tasks to be executed. Such a profile would normally include attributes such as level of education and experience with computer systems. The system designer tried to do this; however, there was no existing operation to work from, and the designer utilized a proxy to substitute for actual operators. Additional benefits could have been derived had there been a prototype interface (6).

The TIC's organizational structure could benefit from streamlining.

The four-tier hierarchy of program manager, operations manager, supervisors, and operators was perhaps necessary and appropriate in the context of the field test, because TravInfo was newly deployed and depended greatly on the human/manual element in its operations. This structure was, however, somewhat top-heavy. As the system becomes more stable, and enhancements and improvements are made (e.g., to the Telephone Advisory Traveler Service's tracking system and the interface between the California Highway Patrol's Computer-Aided Dispatch system and the Traveler Information

Center), and the level of automation increases, this organizational structure could be streamlined or reorganized, potentially resulting in operational benefits (5).

Operator quality control measures should be established early and maintained throughout the project.

While it is important to hire able staff and initially train them, as was the case with Traveler Information Center operators, it is essential to have regular and frequent training updates and to supervise operators closely. Such attention was not always possible during the field test, because supervisors were over-extended at times. Another important lesson is that operator performance reviews should be instituted early on in the project, which was not the case with TravInfo. Implementing strong operator quality control measures was given lower priority than other operational matters such as completing acceptance testing of the system and addressing both internal and external Traveler Information Center problems. Aggressive operator quality control measures were initially viewed as more of a longer-term issue compared to more basic problems in data collection that needed immediate attention.

Good communication among TIC staff goes hand-in-hand with maintaining high morale.

Maintaining regular two-way communication among all levels of Traveler Information Center staff is important to help insure an appropriate level of involvement from staff members. This is especially important and useful in the solicitation of input from operators, since they work most closely with the data and know the system best from the perspective of day-to-day operations. While some operators would be glad to concentrate their efforts on the minutiae of their individual jobs, others take a more macro-level view and desire and can possibly benefit from a more global perspective. This was especially relevant during the latter half of the field test before there were assurances of TravInfo's continuation, and some operators expressed concerns over the continuation of their jobs (5).

## **6.0 CONCLUSIONS**

As it enters its new phase, TravInfo may find the following recommendations valuable. The Traveler Information Center's operating system needs to be improved to the level of efficiency and automation that was originally intended and the feasibility of redesigning the interface that operators work with to enter and process data should be investigated. The TravInfo operating system needs several enhancements to make it more productive and efficient. Although planned for the field test, they could not be completed. At a minimum, the interfaces between the California Highway Patrol's Computer-Aided Dispatch system and TravInfo and between TravInfo and the voice-processing system of the Traveler Advisory Telephone System need to be automated more. Although operator involvement needs to be retained to allow for more subtle interpretation of data, automating more of the routine tasks would substantially speed the flow of information through the Traveler Information Center and improve response times. Two other immediate, necessary steps are improving the reliability of TravInfo's operating system and coordinating with information service providers over standards for how TravInfo data are formatted and the modes by which they will be delivered.

Although some improvements have been made to the interface since a system administrator was assigned fulltime to the Traveler Information Center, the system has largely been running on an "as is" basis. Some modifications have been made to the existing Traveler Information Center interface design to improve its functioning. They include the removal of rarely used items on commonly used windows and the alphabetical ordering of items to better support the operator in retrieving information. Because the center's performance depends so heavily on how well it supports the operators in performing their jobs, the project team should consider a more thorough revamping that would give careful consideration to the needs and duties of the operators and a review of what has worked and what has not on similar systems. However, it should only be undertaken after a thorough determination of the costs and benefits of such a revision.

New strategies to improve the quality and timeliness of data dissemination in the Traveler Information Center need to be investigated and further assessment needs to be made of operator response time to identify the contribution of operator performance and operator workload so that remedies can be pursued where appropriate. Since TravInfo is only as useful as the data that flow out of its Traveler Information Center, the operators there should be continuously trained in the most efficient methods available to help maintain familiarity with operational changes and to ensure the highest level of performance possible. The project team should also consider supplementing announced reviews of operators' performance with spot checks.

The title of the project asked how well privatizing the operations of regional transportation information centers is working. The operation of TravInfo's Traveler Information Center during the Field Operational Test occurred in an environment in which the day-to-day operations were managed by a private-for-profit contractor though overall management supervision and final decision-making authority were in the hands of a public-sector consortium of transportation-related organizations led by the Metropolitan Transportation Commission. Thus, this operational environment was more of a hybrid, neither completely and exclusively a private sector nor a public sector operation.

Since October 1998 when TravInfo concluded its Field Operational Test phase and entered a transitional period, the operational environment has remained basically constant with only relatively minor changes. Four strategic plans were developed to recommend approaches to implementing major program goals, including a data coverage plan, a regional marketing plan, a standards migration plan and a telecommunications plan. When the new system manager assumes its operational responsibility, ultimate decision-making authority will continue to lie with the public sector whose primary objective is to provide information as a public good. Though there will continue to be public sector management and supervision of a private-sector contractor, the new system manager should have additional autonomy compared with the Traveler Information Center operation's contractor during the Field Operational Test. In addition, with a single contractor responsible for the operation and maintenance of the existing TravInfo system

and the design, implementation, operation, and maintenance of enhancements to TravInfo's Traveler Information Center rather than the multitude of individual contractors during the Field Operational Test, operations are expected to be considerably more streamlined than before and should ultimately bear fruit as a result. Thus as TravInfo transitions to a new, more permanent, and stable part of the Bay Area's information technology infrastructure, though in this hybrid public-private setting, the operation of its Traveler Information Center will continue to improve.

## REFERENCES

1. TRW, Inc., "Deliverable 2.1 System Requirements", Metropolitan Transportation Commission, March 1994.
2. Miller, Mark and Randolph Hall, "TravInfo Field Operational Test Traveler Information Center (TIC) Study (Technology Evaluation Element) Implementation Plan", California PATH Working Paper, UCB-ITS-PWP-95-14, University of California, Berkeley, November 1995.
3. Miller, Mark and Dimitri Loukakos, "TravInfo Evaluation (Technology Element) Traveler Information Center (TIC) Study (September 1996 – June 1997)", California PATH Working Paper, UCB-ITS-PWP-98-7, University of California, Berkeley, March 1998.
4. Miller, Mark and Dimitri Loukakos, "TravInfo Evaluation (Technology Element) Traveler Information Center (TIC) Study: *System Reliability and Communications Interface (9/96 – 12/97)*", California PATH Working Paper, UCB-ITS-PWP-98-21, University of California, Berkeley, September 1998.
5. Miller, Mark and Dimitri Loukakos, "TravInfo Evaluation (Technology Element) Traveler Information Center (TIC) Study: *Operator Interface Component-Phase IV: Institutional Analysis*", California PATH Working Paper, UCB-ITS-PWP-98-30, University of California, Berkeley, November 1998.
6. Miller, Mark and Dimitri Loukakos, "TravInfo Evaluation (Technology Element) Traveler Information Center (TIC) Study: *Operator Interface Analysis-Phase III*", California PATH Working Paper, UCB-ITS-PWP-98-22, University of California, Berkeley, September 1998.
7. Miller, Mark and Dimitri Loukakos, "TravInfo Evaluation (Technology Element) Traveler Information Center (TIC) Study: Operator Response Time Analysis", California PATH Working Paper, UCB-ITS-PWP-2000-9, University of California, Berkeley, August 2000.

8. Guiliano G, R.W. Hall, and J.M Golob. *Los Angeles Smart Traveler Field Operational Test Evaluation*. PATH Draft Research Report No. D95-35. Berkeley, California: University of California, Institute of Transportation Studies, 1995.
9. Multisystems, Inc. *Evaluation of Phase III of the SmarTraveler Advanced Traveler Information System Operational Test*. Final Report. Boston, Massachusetts, Multisystems, Inc, 1995.
10. ITS America – ATIS Committee, U.S. Department of Transportation – Joint Program Office, Washington State Transportation Center (TRAC), *Business Models for Advanced Traveler Information Systems Deployment—Proceedings of the Advanced Traveler Information Systems Business Models Workshop*, ITS America, ATIS Committee, San Diego, California, October 6-8, 1997.
11. ITS America – ATIS Committee, U.S. Department of Transportation – Joint Program Office, Washington State Transportation Center (TRAC), “Resource Materials for the Framework for Developing Advanced Traveler Information Systems (ATIS) Business Models Workshop, Regional Descriptions of Major ATIS Deployments”, ITS America, ATIS Committee, San Diego, California, October 6-8, 1997.
12. <http://www.path.berkeley.edu/itsdecision> (California PATH Program ITS Decision Website)
13. [http://www.itsdocs.fhwa.dot.gov/jpodocs/repts\\_te/9tz01!.pdf](http://www.itsdocs.fhwa.dot.gov/jpodocs/repts_te/9tz01!.pdf) (MMDI Phoenix Evaluation Report, U.S. Department of Transportation, April 2000).
14. [http://www.itsdocs.fhwa.dot.gov/jpodocs/repts\\_te/9xv01!.pdf](http://www.itsdocs.fhwa.dot.gov/jpodocs/repts_te/9xv01!.pdf) (MMDI San Antonio Evaluation Report, U.S. Department of Transportation, May 2000).
15. [http://www.itsdocs.fhwa.dot.gov/jpodocs/repts\\_te/@3301!.pdf](http://www.itsdocs.fhwa.dot.gov/jpodocs/repts_te/@3301!.pdf) (MMDI Seattle Evaluation Report, U.S. Department of Transportation, May 2000).
16. [http://www.its.dot.gov/eval/Metro/Metro\\_ModelDeployments\\_EDLDocs.htm](http://www.its.dot.gov/eval/Metro/Metro_ModelDeployments_EDLDocs.htm) (Other deployment reports from U.S. Department of Transportation Joint Program Office)
17. <http://www.metronetworks.com> (Press release September 23, 1999)
18. <http://www.smartroute.com/releases.htm> (Press release June 12, 2000)

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<sup>1</sup> A request for transit-related information transfers the caller to the selected transit service provider.

<sup>2</sup> A request for carpooling, vanpooling, and commuter check transfers the caller to either RIDES for Bay Area Commuters, Solano Commuter Information, or Commuter Check (an employer-sponsored program).

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<sup>3</sup> This includes the time until the incident is first observed, reported to proper authorities, then forwarded on to the TIC.

<sup>4</sup> A TATS voice-processing system input microphone is located at each operator workstation.