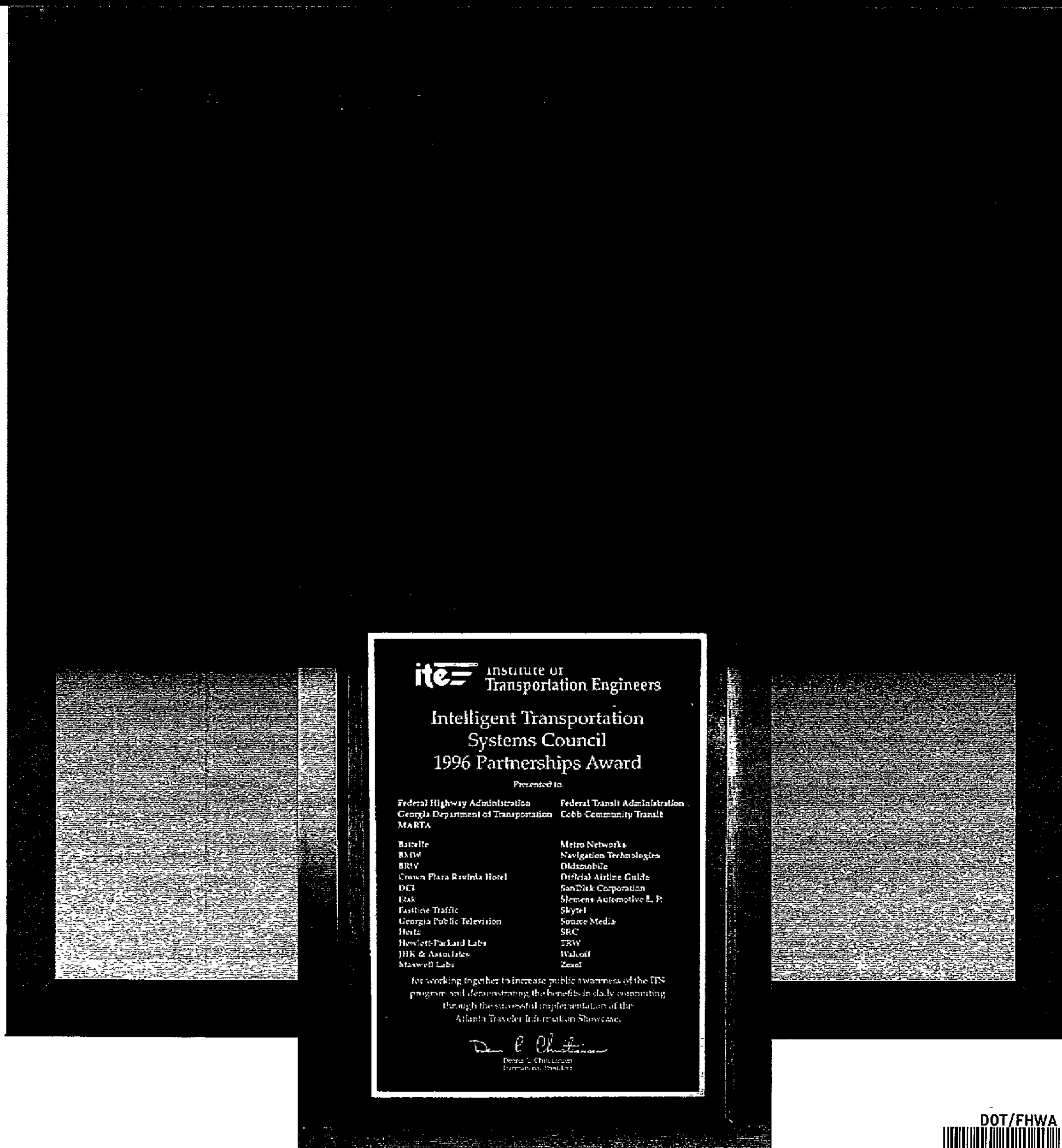
ATLANTA

Traveler Information Showcase

1996

MISSION STATEMENT



DOT/FHWA

150337

Summary Report

ATLANTA TRAVELER INFORMATION SHOWCASE

Submitted to:

U.S. Department of Transportation
Federal Highway Administration
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Acronyms

Acronyms marked with an asterisk (*) are defined in more detail in the Glossary.

ACOG	Atlanta Committee for the Olympic Games
ADAS	Atlanta driver advisory system
APOC	Atlanta Paralympic Organizing Committee
ARATMS	Atlanta Regional Advanced Traffic Management System
ARC	Atlanta Regional Commission
ATIF	ATMS-to-TIS interface
ATMS*	Advanced Transportation Management System
BAP	bearer access protocol or bearer application protocol
CAT	category
CATV	cable television
CCTV	closed circuit television
CODI™	a multimedia NTSC-digital conversion board
COTS	commercial off-the-shelf
CSU	channel service unit
DGPS	differential global positioning system
DSU	digital service unit
DT&E	developmental testing and evaluation
FCC	Federal Communications Commission
FDD	functional definition document
FES*	fixed-end server
FHWA	Federal Highway Administration
FOT*	field operational test
FRAD	frame relay access device
GDOT	Georgia Department of Transportation
GPS*	global positioning system
GPTV	Georgia Public Television
GUI*	graphical user interface
HES	head-end server
HP	Hewlett-Packard
I&O	integration and operation
I&T	integration and testing
IATV	interactive television
ICD	interface control document
IEEE	Institute of Electrical and Electronics Engineers
IR&D	internal research and development
ISDN	integrated services digital network

ISP	Independent Service Provider
ITE	Institute of Transportation Engineers
ITIS	International Traveler Information Interchange Standard
ITS*	Intelligent Transportation Systems
ITS Atlanta*	Intelligent Transportation Systems in Atlanta, Georgia
IVS	in-vehicle navigation system
LAN	local area network
LDS	landline data system
MARTA*	Metropolitan Atlanta Rapid Transit Authority
MIL-STD	military standard
MPH	miles per hour
MSBC	message-session-based client
NOC	network operations center
NTSC	National Television Standards Committee
OLS	on-line server
OS	operating system (e.g., Unix, Windows)
OT&E	operational testing and evaluation
PARIS™	Passenger Routing and Itinerary System
PBX	private branch exchange
PCA/FCA	physical configuration audit and functional configuration audit
PCD	personal communication device
PCMCIA	Personal Computer Memory Card International Association
PMU	personal messaging unit
POTS	plain old telephones (referring to lines)
PR	public relations
PTG	personal travel guide
PTZ	pan-tilt-zoom (referring to video camera)
RAM	random access memory
RBDS	radio broadcast data system
RFI	request for information
RFNC	radio frequency network control
ROM	read-only memory
RPU	remote processing unit
SOW	statement of work
SPSS-PC	Statistical Package for the Social Sciences
SQL	Structural Query Language
SRAM	static random access memory
T&E	testing and evaluation
TATS	traffic advisory telephone system
TEMP	test and evaluation master plan
TIS	Traveler Information Showcase
TMC	Traffic Management Center

TOC	traffic operations center
TWS	Traffic Workstation
UDP	user datagram protocol
USDOT	United States Department of Transportation
USERID	user identification
UTP	unshielded twisted pair
VBL	vertical blank line
V-LAN	video local area network
VRTM	verification requirements traceability matrix
WWW*	World Wide Web

Preface

On April 11,1996, Governor Zell Miller officially opened Georgia's Advanced Transportation Management System (ATMS), inaugurating the State's first intelligent transportation system (ITS). Two years earlier, the Federal Highway Administration had selected Atlanta as the site for an ITS demonstration for a number of reasons: the ATMS's capabilities for providing travelers with up-to-the-minute traffic information, Atlanta's Transportation Management Center (TMC), and the 1996 Summer Olympic and Paralympic Games, which would add more than 2 million athletes, coaches, spectators, and other visitors to the city's increasingly congested metropolitan region.

The Traveler Information Showcase was closely integrated with the ATMS and operated from the TMC. During the four-month Showcase demonstration-from June to September of 1996- the Federal Highway Administration and the Georgia Department of Transportation demonstrated to the traveling public of Atlanta, Georgia and to the rest of the world the benefits of intelligent transportation system technology.

This document, prepared under the sponsorship of the Federal Highway Administration, describes the planning, technical approach, operations, and lessons learned of the Traveler Information Showcase.

Acknowledgments

The success of the Atlanta Traveler Information Showcase depended on the individuals from the public and private sectors who worked together toward a common goal. No single company, agency or person can take credit for the successes. Although mentioning the names of everyone who participated in this project is not feasible, we would like to acknowledge some of the key people who contributed to the success of the Showcase:

- Without the foresight of the Federal Highway Administration ITS Joint Program Office, this project would not have been able to demonstrate to the world the availability of ITS technologies and the benefits they offer to travelers.

- Mr. Larry Dreihaup, Georgia FHWA Administrator, provided the guidance and resources needed to keep the project moving forward.

- We are also indebted to Mr. Felton Rutledge of the FHWA; his knowledge of the area and his willingness to provide daily guidance and needed introductions with city and state personnel proved to be invaluable.

- Ms. Marti Hron, Mr. Chris Long, and Ms. Susan Bruce of the FHWA provided excellent reviews of the Showcase's engineering work.

- We also would like to acknowledge the contribution of Ms. Shelley Lynch: her insistence on integrated products in Atlanta forced us all to deliver better systems that work together.

- The Georgia Department of Transportation made a tremendous contribution to this project. In particular, Mr. Marion Waters and Mr. Joe Stapleton welcomed the Showcase operations center into the new GDOT ATMS facility and provided space and support that facilitated the successful operation of the Showcase. The partnership between GDOT and Showcase staff made the Showcase work.

- Ms. Susan Schruth and the Federal Transit Administration supported the transit-related aspects of the Showcase. Metropolitan Atlanta Rapid Transit Authority (MARTA) personnel, including Mr. Rick Simonetta, Ms. Harriett Robins Smith, and Mr. David Goglia, also assisted in the transit features of the Showcase.

- The Policy Committee-Dr. Christine Johnson, Mr. Dennis Judycki, Mr. Wayne Shackelford, Mr. Leon Larson, Ms. Susan Schruth, Mr. Larry Schulman, and Mr. Richard Simonetta-made their time available to assist in the critical decision-making needed during the Showcase. Their willingness to work with us and their insight into the program kept us all focused on our objectives.

The entire project team thanks all of the companies and the individuals who used the devices deployed during the Showcase. They made it possible for us to demonstrate that the public really can use advanced transportation technologies to increase the efficiency of our nation's highways.

Executive Summary

EXECUTIVE SUMMARY

The idea of an Intelligent Transportation System (ITS) in the United States began more than 10 years ago as an effort to evaluate the potential application of telecommunications and computer technology advancements to address the needs and problems of the U.S. highway, rail, and transit infrastructure. During the past five years, this initiative has been tested and demonstrated throughout the United States, and the benefits are increasingly convincing: reduction of harmful environmental impacts, safer travel, efficient use of highways, informed travelers making informed travel decisions.

Although the benefits of ITS are well known to transportation professionals, everyday travelers-including private and commercial operators-most often are unaware of advanced traveler information systems (ATIS) and the impact that ATIS can have on their driving experiences. The goal of the Atlanta Traveler Information Showcase was to demonstrate what traveling in a metropolitan area will be like as ITS infrastructures are developed. This federally sponsored demonstration enabled the general public to experience ITS firsthand, and it allowed the private sector to see the opportunities available for continued ITS enhancements and applications, thus advancing the U.S. ITS initiative.

Recognizing the Problem

Traffic conditions in the United States continue to worsen. People sit in traffic as vehicles dump tons of pollutants into our environment. Much of the congestion is caused by dreadful accidents, which often lead to more accidents as drivers observe the accident or grow impatient with traffic and try to circumvent a tangled web of automobiles.

Figure ES-l. Traffic congestion often leads to accidents and increases negative environmental impacts.

In the past, we have tried to solve transportation problems by building more roads to accommodate more automobiles and trucks. However, in many urban areas where more capacity is needed (e.g., Los Angeles, Houston, New York), space limitations and the environmental impacts of increased automobile use prohibit the expansion (Figure ES-l). New solutions must be found.

Computers and associated information, control, and communications systems have provided tools that can provide new opportunities for significant transportation improvements. Engineers and scientists are testing and evaluating research and development activities of the last decade.

The dilemma, however, is making commercial and private travelers aware of the technological advancements of ITS. The solution? Put the technology into the drivers' hands and let them experience ITS. Offer online services from which drivers can gather information before reaching a congested highway. Give travelers the opportunity to use ITS.

Demonstrating a Solution

The Traveler Information Showcase implemented in Atlanta, Georgia, during the summer of 1996 did exactly this. The project did not demonstrate all ITS functionality, focusing instead on automated traveler information systems (ATIS). ATIS provides the best way to show travelers what benefits are possible using ITS because most of the systems are targeted directly for use by travelers.

The Federal Highway Administration selected Atlanta for several reasons:

- From 1982 to 1992, congestion in the metropolitan area grew by 29 percent
- The city's population grew by 36 percent from 2.4 million to 3.3 million from 1983 to 1993
- The most recent Texas Transportation Institute congestion survey rated Atlanta tenth among the most congested cities in the United States
- During the summer of 1996, 2.5 million athletes, coaches, and spectators would visit Atlanta for the Olympic and Paralympic Games
- In the Spring of 1996, the Georgia Department of Transportation would open its $11 million Transportation Management Center in Atlanta, part of the $140 million Advanced Transportation Management System.

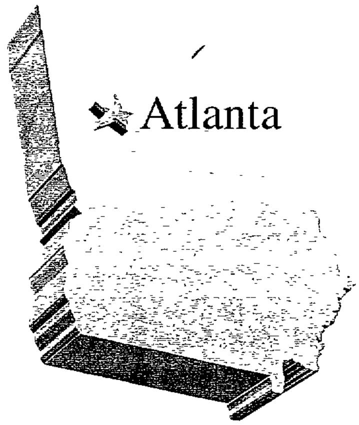

Figure ES-2. The FHWA selected Atlanta, Georgia, as the demonstration site.

The TIS took advantage of the Summer Olympic Games held in Atlanta in July of 1996, and demonstrated the potential of advanced traveler information systems to a constantly moving audience of nearly 6 million people (Figure ES-2).

The Origin of the Showcase

After holding a number of discussions about the feasibility of conducting the proposed Atlanta Showcase project, the U.S. Department of Transportation awarded a contract to Battelle, a not-for-profit technology development organization located in Columbus, Ohio, on February 3, 1995. The contract award followed a number of discussions which began in December 1994 and included a four-week feasibility study that assessed the risk in performing a Showcase in the allotted time and determined the funding that would be required. The feasibility study included discussions with people in Atlanta (i.e., Georgia Department of Transportation, Olympic Committee, FHWA regional offices), potential subcontractors, and independent service providers in each of the five technology areas. Also, while the feasibility study was being completed, the FHWA advertised in the *Federal Register* for technology service providers who might be interested in participating as a partner in the project. At the end of the study, it was determined that the demonstration Showcase could be accomplished for an estimated cost of $14 million.

The Showcase Team

Recognizing the wide range of issues to be addressed and the compressed schedule for accomplishing the Showcase objectives, Battelle quickly formed a core team of subcontractors to develop the supporting infrastructure, and a team of independent service providers to implement the five selected technologies. Table ES-l shows Battelle's core team.

Table ES-l. Battelle Developed a Core Team for the Showcase Project

TEAM MEMBER	ROLE
Battelle	Prime Contractor, Systems Integrator, and Project Manager
BRW	Operations Management
JHK & Associates	Traffic/Incident Surveillance Systems
System Resources Corporation (SRC)	System Testing and Communications Support
TRW	Centralized Computer System Development
Walcoff & Associates	Public Relations and Outreach

The development team also included engineering staff from the public sector. The Federal Highway Administration, Georgia Division, assigned three staff engineers to the project. These engineers worked closely with the Battelle team to ensure that the objectives of the U.S. DOT were met and that needed decisions and other administrative matters were addressed efficiently and effectively. The Showcase project was guided by a Policy Committee of Transportation leaders with a strong interest in seeing the Showcase succeed. The Policy Committee met in Atlanta every two months to review the project status and make decisions as required concerning the direction of the project. Table ES-2 identifies the Policy Committee members.

Developing the Showcase Infrastructure and Technologies

A substantial amount of work was needed to provide the infrastructure to allow the technology systems to operate. In particular, a centralized computer system was required to service information requests by the selected devices as well as supplemental surveillance systems to capture the real-time congestion, speed, and incident situations at any point in time. The centralized computer system, known as the fixed-end server or FES, was built around a set of sophisticated software tools developed and owned by TRW (Figure ES-3). The system, selected to be compatible with the Advanced Traffic Management System (ATMS) being built by TRW for Georgia DOT, allowed for long-term support of the system as part of the overall ATMS.

Table ES-2. The Policy Committee Ensured That the Project Met U.S. DOT Objectives

POLICY COMMITTEE MEMBER	AFFILIATION
Christine Johnson	Director of the ITS Joint Program Office at the U.S. Department of Transportation
Dennis Judycki	Associate Administrator for Safety and System Applications at the Federal Highway Administration
Leon Larson	Federal Highway Administration Region 4 Office Administrator
Susan Schruth	Federal Transit Administration Region 4 Office Administrator
Larry Schulman	Associate Administrator for Research, Demonstration and Innovation, Federal Transit Administration
Wayne Shackelford	Commissioner of the Georgia Department of Transportation
Richard Simonetta	General Manager of the Metropolitan Atlanta Rapid Transit Authority (MARTA)

A major goal of the Battelle-led team was to use as much off-the-shelf technology as possible and avoid a research and development program. The compressed schedule restricted any major development work. Forty-one responses describing different types of ATIS systems were received from the FHWA's *Federal Register* request. Battelle and FHWA worked together closely and reviewed each submission, using the following criteria to determine if the system was appropriate for the Showcase:

- Technologies that would result in a positive response from travelers
- Teams providing complete solutions
- Ability to implement by June 1, 1996
- Price and offered partnership contribution
- Willingness to use real-time data in the systems.

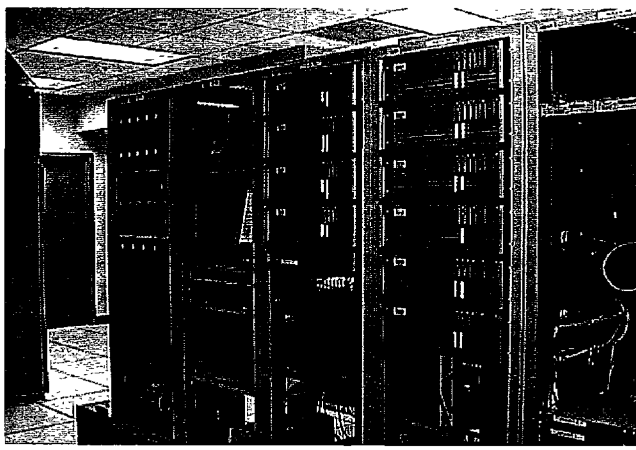

Figure ES-3. The FES provided the heart of the Showcase.

The Showcase management team invited the selected companies to visit Atlanta and present their ideas. Table ES-3 identifies the companies who were selected.

Table ES-3. Independent Service Providers

COMPANY	PROPOSED AFFILIATION
Siemens, Zexel, DCL BMW. Oldsmobile.	In-vehicle route guidance system
ETAK, Hewlett Packard, SanDisk, and SkyTell	HP-200LX personal communications device
Fastline	Motorola Envoy personal communications device
ETAK	A cable television channel
ETAK, MediaOne	An interactive television system in a hotel
Maxwell Laboratories	An on-line system emphasizing use of the Internet

In selecting each team, an effort was made to minimize changes needed to the systems. Each company had put careful thought into their systems to develop products that people would like and buy. Therefore, the functionality of the Showcase was driven by what existed and did not put additional effort in developing new detailed functional specifications. However, some development was needed to include the real-time data in each system. Also, time was needed to integrate and test each system in Atlanta. The management team established a schedule which required that all development work be completed by December 31, 1995. During January, 1996 vendors were to bring their systems to Atlanta and install them into the Showcase Operations Center. From February through May 1996, the schedule allowed for detailed testing and integration, with the firm requirement that the systems be distributed to users by June 1, 1996. The operational period for the Showcase was defined as June 1 through September 30,1996, followed by three months (from October 1 through December 31) to provide an opportunity to interested parties to take over any of the systems as legacy.

The Showcase focused on five core applications-hand-held computers, in-vehicle navigation systems, interactive television, cable television, and an Internet home page-which were complemented by other ITS projects such as Kiosks, variable message signs, high occupancy vehicle lanes, and a sophisticated advanced traffic management system. All systems, including the TIS, were integrated in Atlanta to provide travelers with one of the most sophisticated transportation systems in the world. The five Showcase applications included the following:

- **Personal Communications Devices.** These small, hand-held computers were linked to a central computer system using wireless communications to provide travelers with a host of traveler information (Figure ES-4).

[1]The ETAK personal communications device team actually joined the project midstream replacing another team that was developing a system around the BellSouth Simon product. The Simon product was discontinued in the middle of the project.

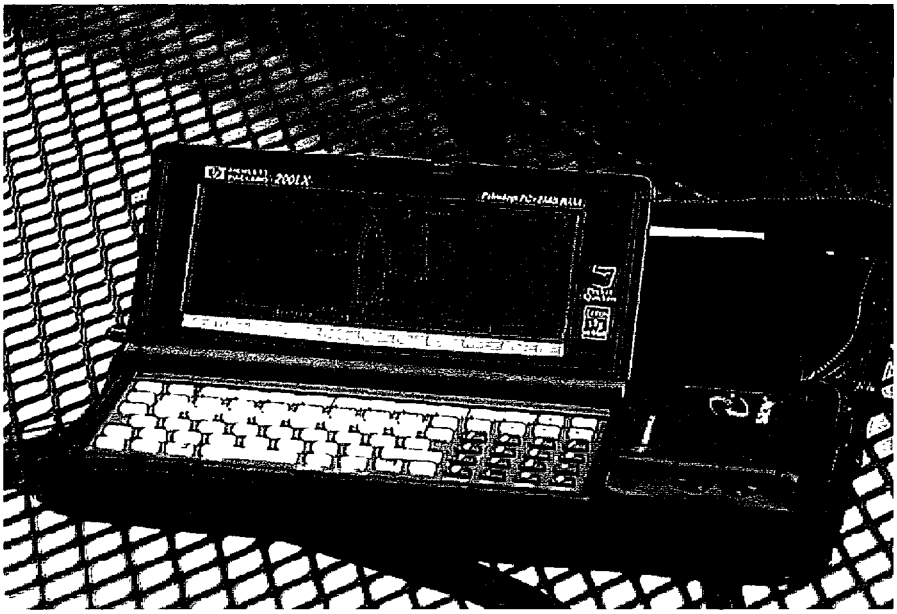

Figure ES4. PCD technology provided wireless communications for Showcase participants.

- **In-Vehicle Route Guidance Systems.** This small on-board computer provided maps showing turn-by-turn directions with real-time traffic, speed, and incident data for drivers in their vehicles Figure ES-5).

- **Cable Television.** The automated traveler information channel provided valuable current pre-trip data 24-hours a day to 750,000 cable subscribers (Figure ES-6).

- **Interactive Television.** Guests of the Crowne Plaza Ravinia Hotel could access this interactive in-room channel for real-time traffic and transit information (Figure ES-7).

- **On-Line Internet Web Page.** Browsing www. georgia-travelercorn provided Internet users with real-time traffic maps, route planning, and links to the MARTA public transit system (Figure ES-8).

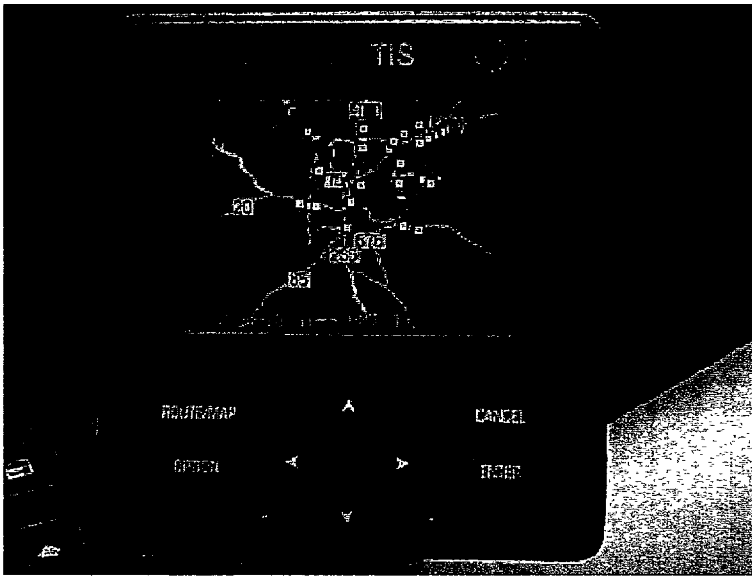

Figure ES-5. In-vehicle devices provided travel and traffic information.

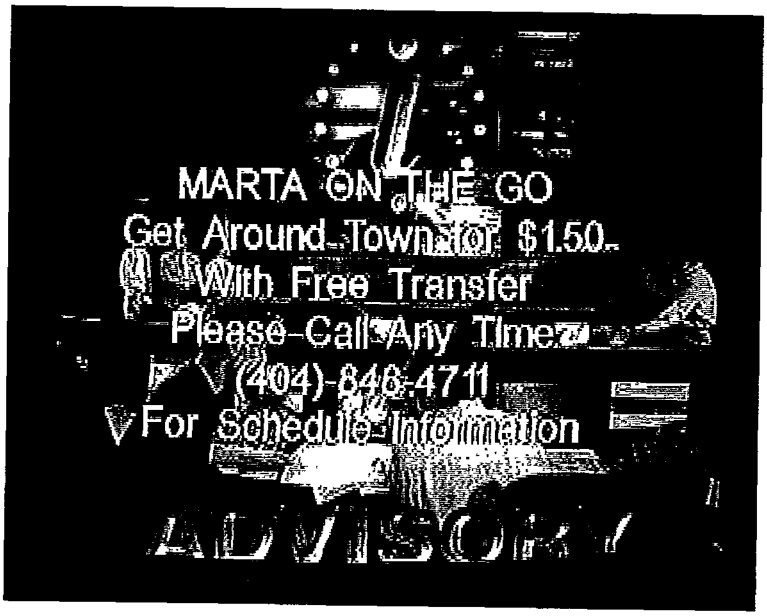

Figure ES-6. The cable television channel provided bulletin-board type messages as well as real-time traffic information.

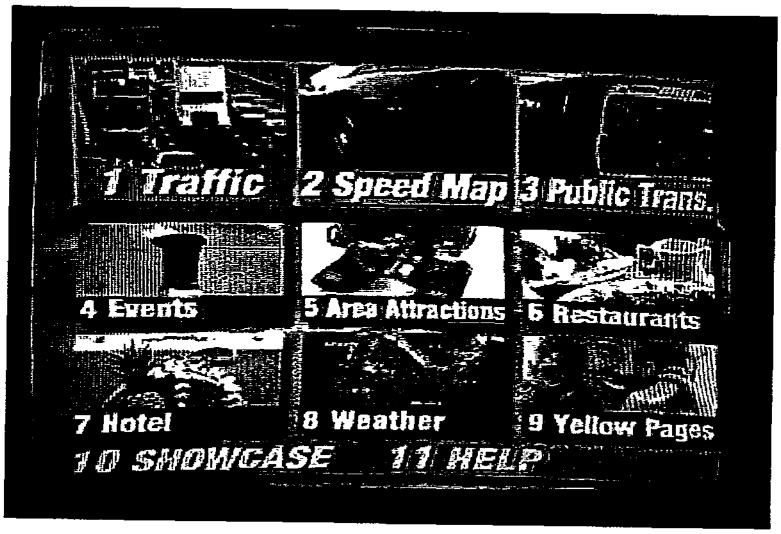

Figure ES-7. Users of the interactive television system could choose the type of information they needed from the main menu.

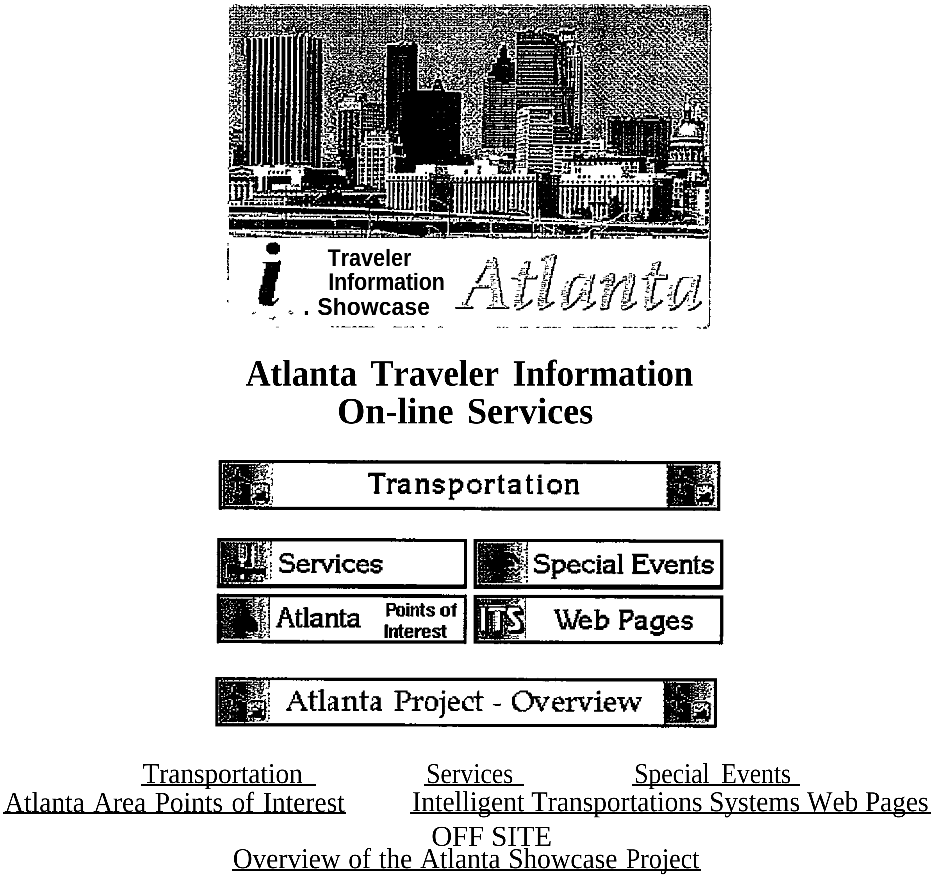

Figure ES-8. The Georgia-Traveler Web page provided users with a number of options.

All systems provided similar types of information to the traveler. A unique feature of each system was the availability of real-time traffic and speed data as well as locations of accidents and road work (Figure ES-9). "Yellow page" information was also available on all devices except the Cable television system. Yellow page information included location of restaurants, emergency services, hospitals, theaters, and museums, as well as directions to each destination using both private vehicles and, in many cases, public transportation. The information focused on creating smart travelers who could make smart travel decisions to increase travel safety, reduce travel times, and minimize stress.

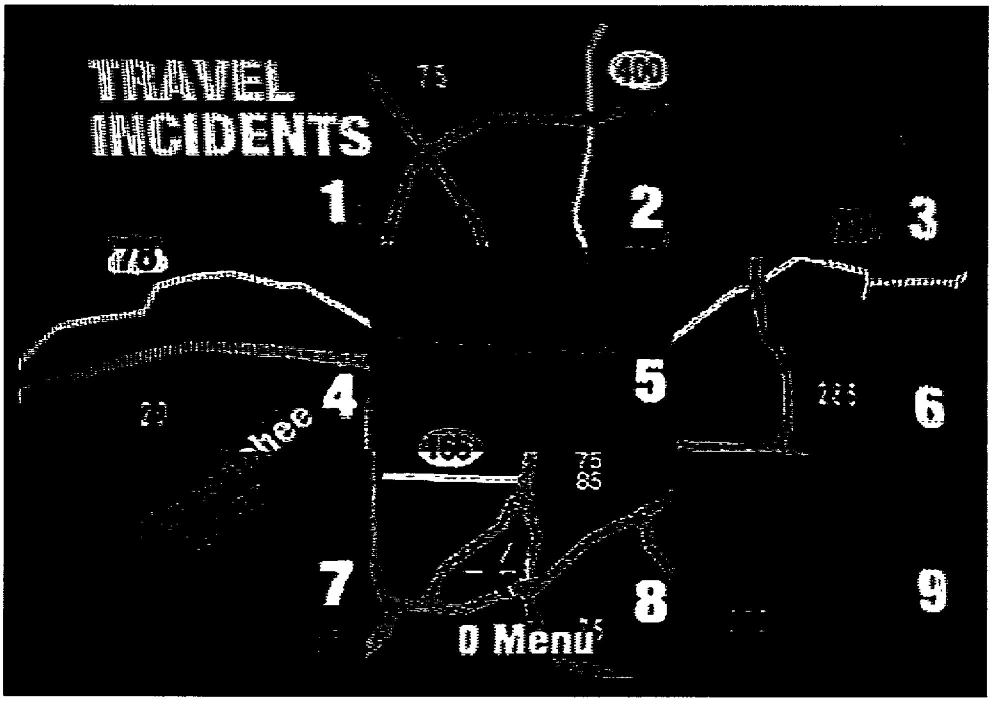

Figure ES-9. The Showcase provided real-time traffic information, as seen here on interactive television.

Gathering Showcase Data

Providing travelers with information required complete and accurate transportation data. Roadway surveillance was the Showcase's largest single task. The Georgia DOT was planning to have complete speed and incident data for I-75 and I-85 running north and south through the city to the I-285 Perimeter boundaries. However, other important areas, such as the I-285 Perimeter and I-20 running east and west through Atlanta, had no consistent surveillance. Also, the Showcase was required to develop surveillance for the major feeders to Atlanta (i.e., I-75, I-85, I-20) to the state borders. When surveillance was being discussed, the team assumed that Olympic spectators would stay in hotels outside the city and drive back and forth, thus creating congestion in the morning and evening hours that would be important to monitor and report.

The surveillance part of the Showcase team, led by JHK & Associates, analyzed different surveillance alternatives and selected the following surveillance methods:

- GDOT incident and congestion data provided as part of the ATMS system

- Radar units installed in 52 locations, identified by GDOT, which reported speed data to the fixed-end server (see Figure ES- 10)

- Twenty-one slow-scan video cameras installed at critical locations, which provided the operator the ability to view traffic upon demand.

- Supplemental traffic information provided by Metro Networks, a professional traffic surveillance company which flew aircraft and operated a mobile spotter system on both the major highways in Atlanta and the major highway feeders extending to the state lines

- Nine mobile spotters who drove the roadways for 16 hours or more each day reporting and checking problem areas, concentrating on the Olympic park & ride lots during the Olympic time period and the major freeways when the park & ride lots were not operating.

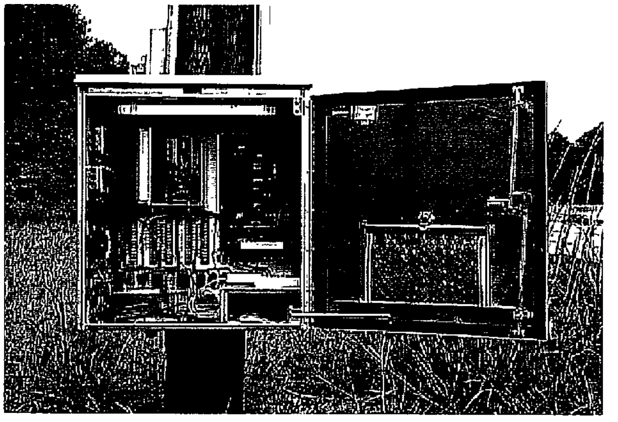

Figure ES-10. Radar units provided key data to the Showcase.

The surveillance system put into place for the Showcase proved to be effective. It was estimated that if congestion or an incident occurred, the Showcase had about an 85 percent to 90 percent chance of detecting the problem.

Marketing the Showcase

In recent years efforts to improve surface transportation through advanced technologies have developed into a national intelligent transportation systems (ITS) initiative. People close to the transportation industry are aware of the potential and operational capabilities of ITS But the general public has little knowledge of ITS and how it can improve their travel experiences. The marketing and public relations required for the Showcase needed to educate the public about ITS and communicate the availability and accessibility of the TIS.

The communications objective of the Traveler Information Showcase public relations program was to capture and present the real-world experience of real-time traveler information in the Atlanta area to targeted audiences. Through discussions with FHWA, six target audiences were identified: local travelers, travelers into Atlanta for special events, transportation professionals, local/national influencers, national/ international large, and the media.

The Showcase marketing effort included press releases, brochures and fact sheets, newsletters, flyers, and media demonstrations, as well as an identifying logo used in all documents. Articles about the Showcase appeared in national publications (see Figure ES-11).

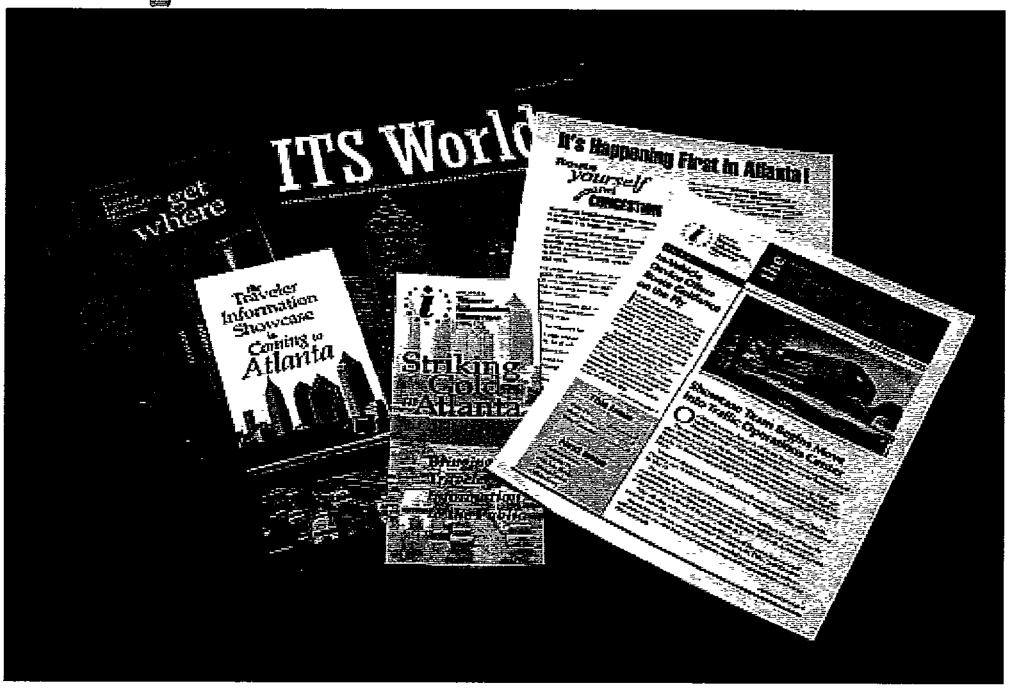

Figure ES-1 1. The Showcase project generated a number of documents, and articles about the Showcase were in national publications.

Operating the Showcase

During the operational period (June 1 through September 30,1996), an operations center, located at the TMC in Atlanta (see Figure ES-12), housed the day-to-day operations of the Showcase.

The Showcase staff consisted of *an Operations Manager* who had responsibility for monitoring the devices, ensuring that they were operating properly, and determining corrective actions that were necessary and following through on implementing them. A *Surveillance Supervisor* was on duty at all times to ensure that the surveillance system was operating properly. The Surveillance Supervisor worked with the radar units, slow-scan video cameras, Metro Traffic, and Georgia DOT to make sure the data were collected accurately and reliably.

The Surveillance Supervisor also had three *Call Takers* responsible for data entry (see Figure ES- 13). Call Takers had data input terminals and telephones. The mobile spotters would call the Call Takers as necessary to report congestion or incidents. They also entered data reported by Metro Traffic. Working as a team, the Operations Manager, Surveillance Supervisor, and Call Takers maintained proper operation of the systems during the operational period.

The operation of the Showcase ran very smoothly. Hundreds of travelers were given the opportunity to use the automated traveler information systems provided by the Showcase. Although the Showase did not identify user assessment as a major task, the team did gather data from users to determine the use and effectiveness of the systems. Information from users of the in-vehicle system, interactive TV, Internet, and personal communication devices was collected using written questionnaires, and cable TV viewers were asked to comment to a hot line. The response to the systems was overwhelmingly positive.

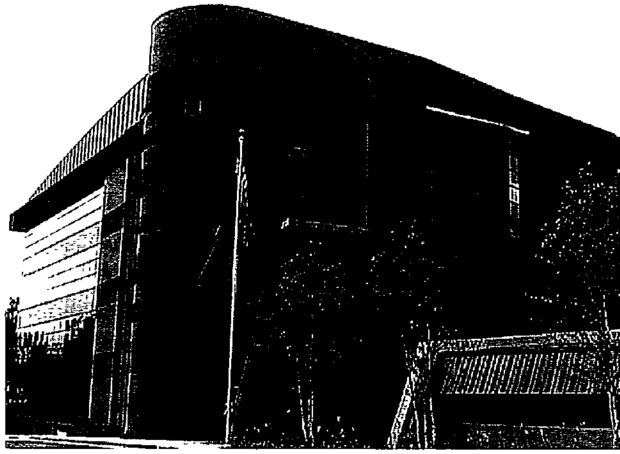

Figure ES12. Showcase operations were conducted from the TMC.

Figure ES-13. The surveillance supervisor and the call takers worked as a team to ensure accurate traffic information.

Continuing the Effort

The Atlanta Traveler Information Showcase was a success, meeting all major project objectives. The Traveler Information Showcase was also recognized as the best public-private partnership for 1996 by the Institute of Transportation Engineers. The Showcase will continue operating through February 28, 1997, which will allow others to see the work that was accomplished in Atlanta to increase the public's awareness of the benefits of ITS technologies.

Introduction and Objectives

INTRODUCTION AND OBJECTIVES

In December 1994, the Federal Highway Administration (FHWA) provided a Statement of Work (SOW) to Battelle under an existing task order contract. The SOW requested Battelle to develop a showcase demonstration of Intelligent Transportation Systems (ITS) during the 1996 Olympic Games in Atlanta, Georgia. The Olympic Games event provided an extraordinary opportunity for the U.S. Department of Transportation (U.S. DOT) to demonstrate ITS technology to a wide-ranging audience of Atlanta residents, and U.S. and international visitors. Atlanta had built an infrastructure of supporting systems which would allow installation of the technologies in the allowable time frame, and the Olympics would attract a large number of visitors-and subsequently extreme traffic and travel conditions.

The U.S. DOT outlined in the Statement of Work five technologies to be demonstrated in the project:

- Personal Communication Devices (PCDs)
- In-Vehicle Route Guidance Devices
- Cable Television
- Interactive Television for Hotels
- On-Line Systems (e.g., Internet, CompuServe, America On-Line, Prodigy).

Although everyone agreed that the Olympics presented an outstanding opportunity, many expressed concern that the work requested could be done on time. The Olympics would start on July 17, and nothing would delay the opening ceremonies. Battelle requested the U.S. DOT to approve a one-month study to investigate the feasibility of performing the defined work in the time available. The Showcase had to be fully operational on June 1,1996; anything less meant an expensive project failure. The U.S. DOT approved the feasibility study. Battelle personnel visited Atlanta and talked with the local U.S. DOT representatives who would be working with the project daily. We also contacted many ITS product vendors (later referred to as Independent Service Providers) to determine their interest. In every case, Battelle received a positive response that led us to believe a successful Showcase was possible. The results of the feasibility study, presented to the U.S. DOT at a meeting in Atlanta, Georgia, on January 5,1996, indicated that Battelle believed the Showcase could be completed. However, to achieve success, the project needed to be handled differently than a traditional system development:

- A non-traditional contract relationship was required. We were approaching a project that was not well defined, and there was not enough time to follow the traditional definition, design, deployment life-cycle. This project was clearly a design-build-design-build project. Battelle requested a partnership with the public sector in which problems would be resolved as a team. Successes would be everyone’s successes, and short falls would be everyone’s short falls. Success meant a public-private partnership.

- Contractual issues had to be dealt with quickly, which meant that the FHWA needed to review and approve all subcontracts within days.

- The FHWA indicated that PCDs were the highest priority technology to be demonstrated. When Battelle investigated the availability of PCDs, many hardware platforms were available, but no software. Therefore, Battelle recommended that two PCD vendors be selected to minimize risk. If one failed, there still would be another PCD unit under development.

- The detailed functional requirements would be developed in conjunction with vendors and available functionality already developed in off-the-shelf systems. Time did not allow for major software development work. Functionality brought to the project by vendors would have to be acceptable as part of the selection process.

Battelle formed and recommended a core team to help develop the supporting system infrastructure and manage the work required for Showcase deployment. Table 1 identifies the core team. Figure 1 provides an overview of the Showcase project organization.

Table 1. The Traveler Information Showcase Core Team Developed the Supporting System Infrastructure

COMPANY NAME	ADDRESS	AREA RESPONSIBILITY
Battelle	505 King Avenue Columbus, OH 43201	Prime Contractor, Systems Integrator, and Project Manager
BRW	Thresher Square 700 Third Street S Minneapolis, MN 55415	Operations Management
JHK & Associates	3500 Parkway Lane, N.W. Norcross, GA 30092-2832	Traffic/Incident Surveillance Systems
System Resources Corporation (SRC)	400 Virginia Avenue, SW Washington, DC 20024	System Testing Communications Support
TRW - Atlanta Engineering Office	4751 Best Road Atlanta, GA 30337	Centralized Computer System Development
Walcoff & Associates	12015 Lee Jackson Hwy. Suite 500 Fairfax, VA 22033	Public Relations and Outreach

The Atlanta Traveler Information Showcase contract between FHWA and Battelle was signed on February 28,1995. The TIS team had 16 months to:

- Form the project team and establish office space in Atlanta
- Locate and contract with suppliers in the five technology areas outlined in the SOW
- Develop any new software necessary to accomplish essential functionality
- Develop and implement a comprehensive traffic and incident surveillance plan
- Develop a centralized fixed-end server to service all devices' information requests
- Develop and install an operations center
- Install all hardware and communications systems

- Integrate and test all systems
- Identify and train users for the devices
- Distribute all devices
- Develop an evaluation program
- Install a comprehensive public relations and outreach program so that people could be made aware of the Showcase operations
- Provide for leaving a legacy upon which Atlanta could continue ITS deployment of ATIS systems.

The day-to-day oversight of the project was assigned to the Division Office of the Federal Highway Administration in Atlanta, Georgia. The Division Administrator, Mr. Larry Dreihaup, served as the technical administrator for the U.S. DOT, which provided the level of management support needed for the project. Three full-time FHWA engineers were assigned to work with the Battelle team. Therefore, the U.S. DOT became integrated into the project on a daily basis, which was instrumental in the project's success.

The U.S. DOT also formed a Policy Committee to provide overall direction for the Showcase. The committee consisted of senior managers from the various modal agencies in the Federal and State Government which could initiate interfaces and make things happen to accomplish the work. The members of the Showcase Policy Committee are provided in Table 2. The Policy Committee met bi-monthly to review project status and make key decisions needed to provide overall project direction.

Table 2. The TIS Policy Committee Provided Overall Direction for the Showcase

MEMBER	TITLE
Christine Johnson	Director of the ITS Joint Program Office at the U.S. Department of Transportation
Dennis Judycki	Associate Administrator for Safety and System Applications at the Federal Highway Administration
Leon Larson	Federal Highway Administration Region 4 Office Administrator
Susan Schruth	Federal Transit Administration Region 4 Office Administrator
Larry Schulman	Associate Administrator for Research, Demonstration and Innovation, Federal Transit Administration
Wayne Shackelford	Commissioner of the Georgia Department of Transportation
Richard Simonetta	General Manager of the Metropolitan Atlanta Rapid Transit Authority MARTA)

As the U.S. DOT was negotiating the contract with Battelle, they published a Request for Information (RFI) in the November *30,* 1994 issue of the *Federal Register* asking vendors to submit ideas and products for inclusion into the Showcase. The vendors were told that in addition to the five technology areas outlined in the SOW, any concept that would be perceived as leading-edge technology and which supported ITS would be considered. Creativity was imperative, and any system was required to support the use of real-time data. Forty-two responses were received in early January 1996, and U.S. DOT and Battelle reviewed all submissions. Those that were deemed potentially acceptable were invited to Atlanta to make a presentation. When appropriate, a visit was made to the vendor's site to see their systems to ensure they had what they claimed. (This was not based on a lack of trust, but on the realization that most companies are very optimistic in their marketing ventures.) After several weeks of negotiations, a team of vendors, referred to as Independent Service Providers (ISPs), was selected. Table 3 summarizes the initial set of ISPs that provided technology solutions for demonstration.

Table 3. The Independent Service Providers Provided Technology Solutions for the Showcase

ISP TEAM NAMES	CONTRIBUTION
Siemens, Zexel, DCI, BMW, Oldsmobile, Navigation Technologies	In-vehicle route guidance system
ETAK, Hewlett Packard, SanDisk, and SkyTel[1]	HP-200LX personal communications device
Fastline	Motorola Envoy personal communications device
ETAK	A Cable Television channel
ETAK, Source Media	An Interactive Television System in a Hotel
Maxwell Laboratories	An On-Line System emphasizing use of the Internet

The Showcase team told the project ISPs that they had to complete new development work by December 31,1995, and have the work installed for system testing in Atlanta on January 3 1,1996. The Project Plan identified the months of February through May 1996 as time for testing and integration. All ISPs had good intentions, but some did not make the defined schedules. In fact, on December 31,1996, only Siemens/Zexel (In-Vehicle ISP) had delivered their systems. Other ISPs arrived in Atlanta with their respective systems between February and April, which created a scheduling problem and the test team had to revise the testing approach. Many integration and testing activities occurred in parallel. However, the systems were tested and installed on June 1,1996. Very few software or hardware changes were needed after the June 1,1996 start of the Showcase. The ISPs did an incredible job of delivering reliable systems that passed testing rapidly.

As the systems were being tested, work progressed to identify the users for the systems. User identification focused on both residents of and visitors to Atlanta. Devices were distributed through a rental car agency, the airport SkyTel booth, the Olympic Committee, and by area businesses, hotels, hospitals, and public agencies. The businesses were encouraged to allow several of their employees the opportunity to use the lTS technology. We asked each user to return a questionnaire in an attempt to collect user-evaluation data. However, it is important to realize that user evaluation was not a major objective of the Showcase project. Of the $14 million allocated for the project, $60,000 was budgeted for user evaluation. The main objective of the Showcase was to provide the opportunity for travelers to experience ITS and extend the visibility both locally and nationally through an intensive public relations and outreach program.

[1] The ETAX personal communication device team actually joined the project midstream, replacing another team that was developing a system based on the BellSouth Simon product. The Simon product was discontinued in the middle of the project.

Early in the project, a detailed PR plan was developed and approved by the U.S. DOT (the PR Plan is included as an appendix to this document). The plan provided for media relations activities, publication and distribution of written materials (e.g., brochures, newsletters, papers, pamphlets), television and radio interviews, and other outreach activities. The goal was to make a limited number of devices visible to many people from across the United States. The PR program was extremely successful: more than 100 articles were written; public service announcements aired on 15 Atlanta radio stations; Showcase officials were interviewed by four national radio programs and Shelley Lynch of FHWA was interviewed by eight local radio stations; the Showcase hosted video crews or provided video for more than 20 international, national, and local television programs and video services; and 50,000 pieces of literature were distributed. The Showcase technologies were seen by thousands of people internationally.

The Showcase came on line on June 1, 1996, as scheduled. The project operated as planned through September 30, 1996, and was an outstanding success. Many people had the opportunity to use the five ITS technologies and thousands more were exposed through the media work. The Showcase operational period was extended from September 30,1996 to February 28,1997 to provide more time for people to see what was accomplished. In addition, work was performed to leave a legacy of the project in the Atlanta area upon which ITS can build and expand. Of the five systems, the Cable TV, Interactive TV, and Web Page are expected to remain (as of the time of this report). Cable TV suppliers continue to broadcast real-time traffic information and World Wide Web users can see traffic conditions in Atlanta by accessing the Showcase's Web site. Source Media continues to expand their on-line interactive TV system which has real-time traffic information included. Therefore, ITS is surviving in Atlanta as a direct result of the Showcase project.

The following sections of this report summarize the Showcase system, work performed, problems experienced, and "lessons learned" for each technology and the infrastructure needed to support the system:

Chapter Two-Technical Approach-provides a comprehensive discussion of the key areas of the Showcase: systems integration, the fixed-end server, surveillance and data collection, Olympic coordination and operations planning, marketing and public relations, systems testing and engineering, communication infrastructure, and information distribution. The information distribution section includes detailed discussions of the personal communication devices, in-vehicle device, on-line services, cable television, and interactive television. Chapter Two also addresses user assessment[2] and distribution and legacy operations.

Chapter Three-Results, Accomplishments, and Lessons Learned-provides a summary of the Atlanta TIS experience and offers "lessons learned" for others considering a demonstration of ITS technologies.

The remaining four sections of this report provide a comprehensive list of all companies that participated in the program, a glossary of relevant technical terms, a bibliography of the TIS media coverage, and a list of associated documents, which are provided as appendices under separate covers.

[2] Extensive details for the user assessment are included in the User Assessment Appendix.

Technical Approach

TECHINICAL APPROACH

The technical approach adopted for the Traveler Information Showcase (TIS) focused on integrating "off-the-shelf' technologies wherever possible. There was not sufficient time to design each component of the system from the ground up. Wherever possible-for the core team and the independent service providers-organizations were selected with proven technologies that could be adapted to the TIS concept with minimal design and development time. Even with this focus, a significant amount of design and development effort was required by the core team members for the infrastructure as well as the independent service providers for the information distribution technologies.

Much of this additional development work was required to accomodate inclusion of real-time traffic data (a requirement for inclusion into the Showcase) into the existing applications. Obviously, some systems required more development work that others, but the overall approach was to minimize development work as much as possible to reduce the risk associated with software development in such a short timeframe.

As the project progressed, a decision was made to integrate the Showcase with the other ITS projects underway in Atlanta, collectively known as ITS Atlanta. One role of this integration effort was to design into each subsystem a similar look and feel of the various applications. One of the major activities in this area was the development of "standard" icons to be used to represent the real-time traffic information. It was important that users of the ITS technologies in Atlanta be able to transfer their learning from one system to another.

As discussed in the Introduction, the TIS consisted of three major components: surveillance and data collection; central processing; and output devices. Figure 2 shows the architecture of the Traveler Information Showcase.

The team assembled for the TIS consisted of a core team and independent service providers (ISPs). The core team was responsible for establishing the infrastructure (surveillance and central processing) needed for the TIS, TIS Operations, marketing and public relations, and overall systems testing and integration. The ISPs were selected to provide technology solutions to the information distribution needs identified by the U.S. DOT. These technology areas included personal communications devices (PCDS); in-vehicle navigation devices; on-line (Internet) services; cable television; and interactive television.

The remainder of this section describes in detail the objective, approach, implementation, and lessons learned for each of the core areas as well as each ISP technology area: Showcase Systems Integration, Fixed-End Server, Surveillance and Data Collection, Olympic Coordination and Operations Planning, Marketing and Public Relations, Systems Testing and Engineering, Communications Infrastructure, Information Distribution (which includes the five key technology areas), Technology Distribution and User Assessment, and Legacy Operations.

Showcase Systems Integration

Showcase Systems Integration

The Traveler Information Showcase required a fully integrated system to demonstrate that advanced intelligent transportation systems are effective in improving transportation safety and efficiency. The Showcase system was integrated with Atlanta's intelligent transportation systems.

OBJECTIVE

The goal of the Showcase systems integration was to design, build, integrate, test and evaluate, operate, and maintain a complex Traveler Information Showcase (TIS) in the Atlanta Intelligent Transportation Systems (ITS) infrastructure.[3] The TIS needed to be able to request or accept input data from automated and manual sources, including the following:

- The Georgia Department of Transportation's new Atlanta Regional Advanced Traffic Management System (ARATMS) or ATMS
- The itinerary planning and schedule database service functions in the new ITS facility at the Metropolitan Atlanta Rapid Transit Authority (MARTA)
- Via ATMS, speed data drawn from Autoscope™ devices and TIS-installed fixed radar sites, or directly from TIS-installed fixed radar sites
- Manual input from Call Takers who received the raw or preprocessed information from roving spotters, Metro Traffic surveillance and reporting services, GDOT full-motion video or TIS slow-scan video, and calls from the public or project-affiliated staff and device users.

The integrated TIS was based on a client-server architecture using a fixed-end server (FES) with the ability to interact with and disseminate travel information to a variety of external Independent Service Provider (ISP) systems and devices.[4] The external ISP systems included the Motorola Envoy using the ARDIS wireless radio network, the HP2OOLX Palmtop PCD using SkyTel two-way paging, the Siemens/Zexel in-vehicle device using FM subcarrier, cable television by ETAK to local cable providers, interactive television by ETAK and Source Media, and the Web server developed by Maxwell Technologies.

Figure 3 illustrates these general input and output external interfaces and external systems and devices.

[3] ITS Atlanta refers collectively to all systems which were under development or being enhanced for deployment in the Atlanta region during this pre-Olympic timeframe: the GDOT Atlanta Regional Advanced Traffic Management Systems (ATMS), the GDOT/JHK Kiosk project, the FHWA/Scientific Atlanta Automated Driver Advisory System (ADAS) Field Operational Test (FOT), the MARTA/TRW ITS MARTA project, and the FHWA/Battelle Atlanta Traveler Information Showcase (TIS) project.

[4] For more specific detail on the FES, the ISP systems and the communications infrastructure, please refer to the individual sections that follow in this report.

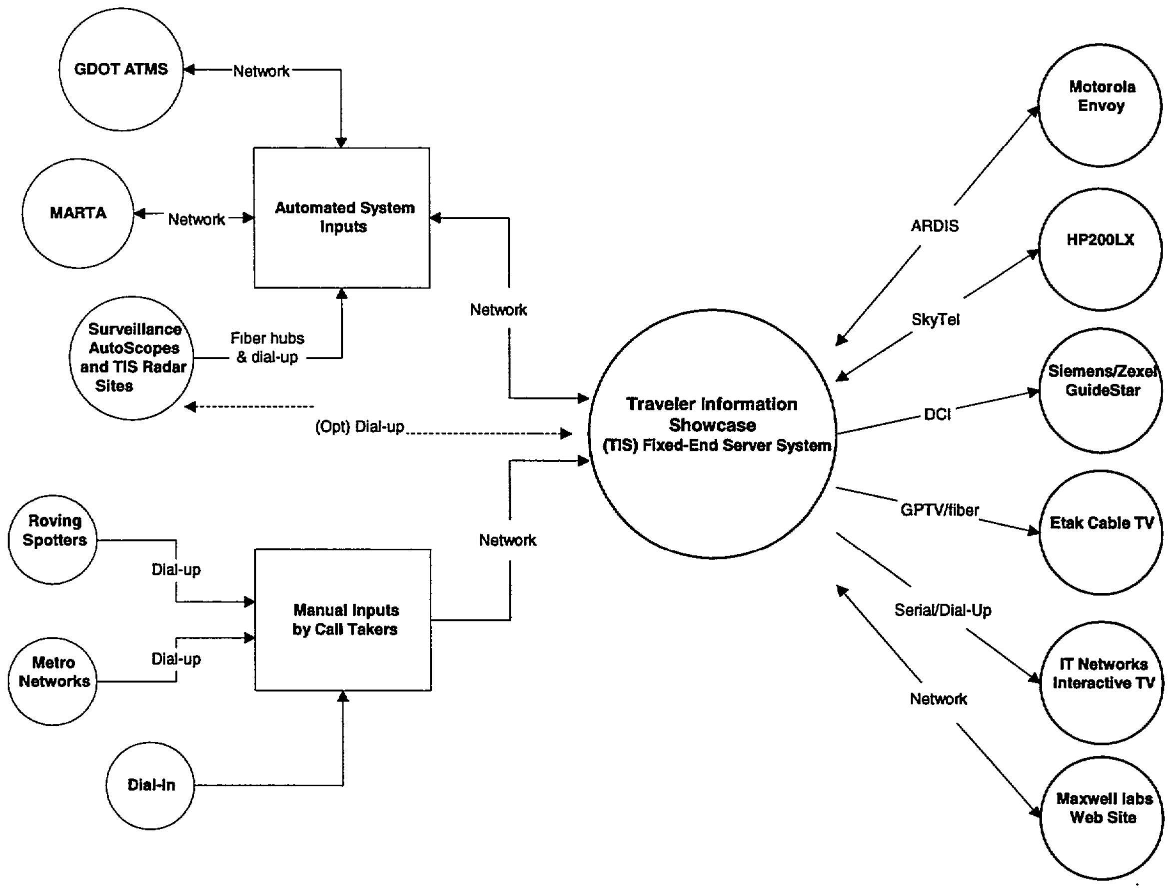

Figure 3. The FES received data from TIS sources and disseminated information to external systems and devices.

APPROACH

The original contractual direction and concept was to have an independent TIS to avoid interference with other mission-critical production systems in ITS Atlanta (e.g., ATMS, ITS MARTA). This independent approach would have included the following:

- Speed (from Autoscope™ virtual loops) and incident data extraction from the GDOT ATMS
- Independent supplemental TIS data collection from radar surveillance sites, slow-scan video, roving spotters, and Metro Networks
- Minimum risk and maximum chance for success based on a relatively independent, controlled environment for TIS operations, and minimal interference and impact on other concurrently emerging systems.

In the Summer of 1995, however, the project team revised the TIS concept to a seamless integration with ATMS, ITS MARTA, Kiosk, and Automated Driver Advisory System (ADAS) in the ITS Atlanta infrastructure. The TIS was not directly connected to the Kiosk and ADAS, but it was essential that the information be consistent across all these systems. This new approach included more clearly defined and regionally mandated access to expanded data sources (e.g., from ATMS, ITS MARTA), and it made more sense for legacy transition aud operations, and for the potential supplemental and failover uses of TIS.

Alternatives Considered

Several alternatives to the physical location of the system components and the interconnecting communications infrastructure that were considered included the following (ranked from most to least desirable option):

- Physical location of all TIS components in the new GDOT Traffic Management Center (TMC)
- Distribution of planned legacy and non-legacy systems and components to locations in the TMC, and other locations outside the TMC (e.g., Cable TV subsystem to TMC or Georgia Net; Web site to TMC, Georgia Net, or GDOT Headquarters; HP2OOLX ISP subsystem to Battelle office suite)
- Physical location of the TIS components in the Battelle offices at 1718 Peachtree St. NW in Atlanta.

Alternatives Selected

The project team agreed that the benefits of seamless integration could best be achieved by co-location of all TIS components and ISP subsystems in the GDOT TMC, Building 24,935 E Confederate Avenue SE, Atlanta. This approach reduced the communications infrastructure requirements; enabled a more focused installation, operational, and maintenance environment; and made sense for the installation pi-e-positioning of potential GDOT legacy components and ISP subsystems.

IMPLEMENTATION

Planning and implementing the installation, operation, and maintenance for the system integration effort paralleled the testing and evaluation (T&E) effort (described in Systems Testing and Engineering). The team established a detailed schedule for TMC move-in, FES installation and testing, all ISP deliveries with installation and testing, and initial functional testing for continuity and service quality of all communications paths before T&E began. This schedule proved to be dynamic, which required flexibility for the adjustments in scope or schedule of the 11 independent TIS interfaces and external infrastructure needs, such as the TMC construction, ATMS, MARTA, TIS surveillance package, six ISPs, and the FES). The mandated ITS Atlanta integration effort also included significant coordination of installation, testing and evaluation, and data management with ATMS, MARTA, Kiosk, and ADAS in ITS Atlanta.

The following section chronicles the steps taken in the TIS integration, with issues and resolutions mentioned where they occurred. Many of these activities occurred concurrently but have been separated for this discussion.

TMC Preparation and Move-In

The TIS project was allocated administrative and operating space in rooms 307, 124, 112, and 119 of the GDOT TMC. In the Summer of 1995, the project team anticipated occupying the TMC facility in November or early December of 1995. However, construction issues and the building inspection and certification for occupancy process delayed opening until early January 1996. The TIS team move-in began on January 8. At this time, the office phones were not working, and once they were working, we did not know outside phone numbers and had no instructions on how to operate the units to retrieve voice mail messages which were then accumulating. To solve this problem, we negotiated a high priority for completing the phone installation. With help from the security guard, we were able to deduce the phone numbers by trial and error, and begin retrieving our voice messages.

TIS Administrative and Operations Room. Room 307 (Figure 4) was a pre-designed room with 4.5 cubicles and an open area at the room entrance near the door. The room was to house the administrative work spaces for the Test Team (SRC/Battelle); the FES development team (TRW) including one Systems Administration X-Terminal and one FES (of the two); the resident Integration Manager's (Battelle) office; and as-needed workspaces for other team members. The room also was to include a TIS demonstration display table, the operations quality control equipment suite, and the HP2OOLX ISP subsystem.[5] The TIS-unique wiring of Room 307 was incomplete when the project team moved in and installed initial hardware (administrative and operational), delaying the planned interconnection of all equipment. To solve the problem, the team installed the wiring over the floor to get up and running in minimum configuration.

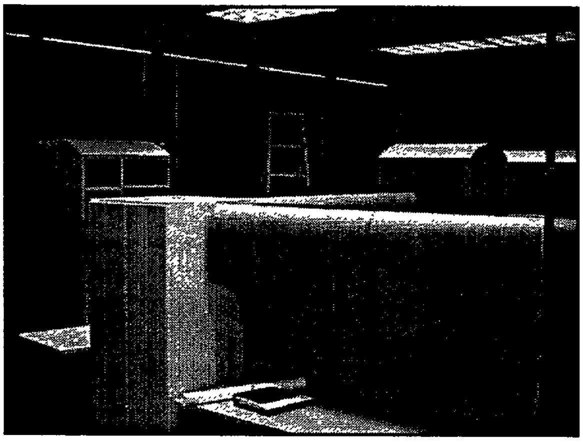
Figure 4. TMC Room 307-Before move-in.

Equipment Room. Room 124 (Figure 5) was the TMC equipment room complete with racks designated and planned for use by TIS. The racks were to contain both the primary and secondary FES, the ARDIS communications gateway server, the Web server, and all ancillary hardware needed for the front ends of the communications infrastructure for both internal and external connectivity. Move-in and installation of TIS equipment in Room 124 was accomplished after dealing with two major issues:


Figure 5. TMC equipment room-Showcase racks.

- The promised racks were not available but occupied by some other system. The TIS team purchased and installed two new racks.

[5] The HP200LX ISP subsystem was placed in Room 307 because it was not to be included as part of the legacy operation and would be more easily removed from this location at the close of the project.

- The uninterruptable power supply was not available as planned, so dedicated TIS power drops were contracted and installed as part of the continuing clean-up work by contractors in the building.

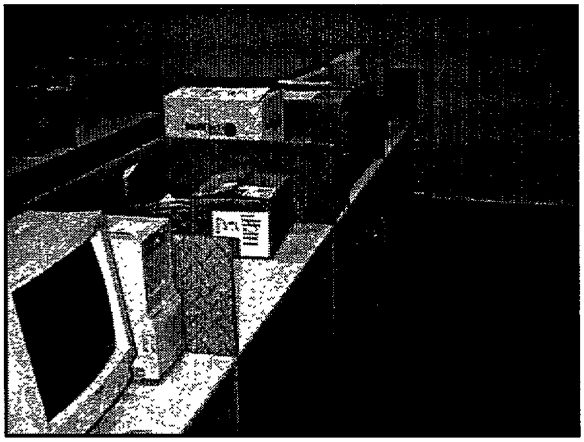

Figure 6. Room 112-Before installation (looking to right).

Call Taker Operations. Room 112 (Figures 6 and 7) was designated as the Call Taker operations area. The TIS project was given the back row of four cubicle workspaces, each with a dedicated telephone, for operational use. The TIS team planned to install four X-Terminals for use by three Call Takers and one Surveillance Supervisor. The team also planned to install three video monitors, a Metro Networks data terminal, and a rack with manual controls for the TIS slow-scan video sites in the event of ATMS failure. The three video monitors were installed on a custom-built shelf mounted on the top of a locker/coat closet at a height of approximately six feet.[6] To clear workspace for the computer terminals, the team removed dividers between the cubicles and installed the Metro Networks terminal between two workspaces. The rack housing manual backup controls for the slow-scan video sites was installed at the end of the row. The remainder of the installation (e.g., wiring, dedicated line for Metro Networks, telephone setup) was accomplished without major problems.

Figure 7. Room 112-After installation (looking to left).

Although the original TMC drawings designated Room 119 (Figure 8) as the Broadcast Room, FHWA, GDOT, and Battelle/ETAK agreed to position the cable TV ISP subsystem in the room in anticipation of the subsystem remaining for legacy use. Because a GDOT Traffic Advisory Telephone System (TATS) was pre-installed in the room, we had to avoid damaging or obstructing the system or affecting operator access with the TV subsystem installation. When the layout was known, a suite of TMC-compatible furniture was ordered for installation in this room to position the complete cable system for operations.

The cable TV equipment list and architectural lay-out plans were not available because of design changes; however, GDOT staff required detailed engineering drawings of how all the equipment would fit into the room before approving the TIS team's use and occupancy. The team worked closely with GDOT to secure approval. The team also experienced significant delays in ordering the furniture (3 to 4 weeks) and then a significant waiting time for the order to be filled (approximately 6 weeks). The team borrowed. GDOT furniture during the interim.

6 This setup initially caused safety concerns, but it has proven to be quite safe.

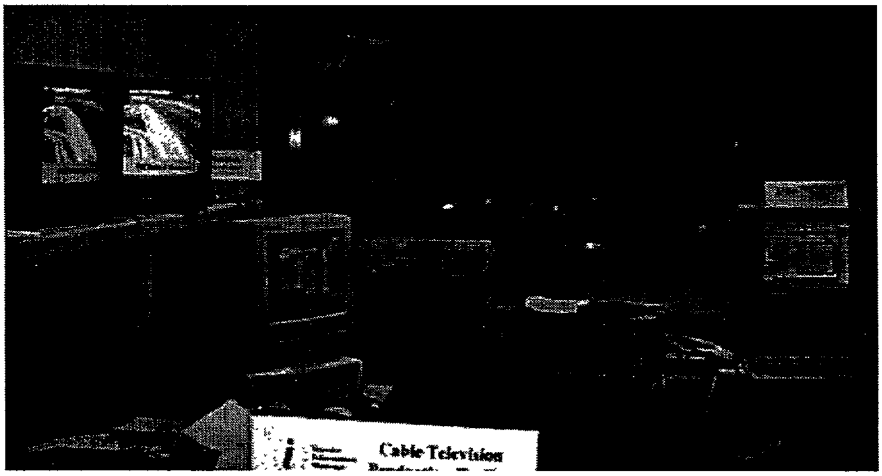

Figure 8. Broadcast Room 119-Operational installation.

Analysis, Design, and Action fo Wire the Host Infrastructure

The TMC facility provided standard office phones and GDOT network connections. The project team required additional wiring and service to include analog lines for use by modems and facsimile equipment, our own TIS-unique network connections, and numerous serial data and video connections between system components. The development of individual ISP subsystem design and interface wiring/cabling requirements was left to the ISP teams. They were directed to provide their stable interface needs, in terms of host infrastructure, to the Integration Manager by the end of 1995. ISPs also were expected to contract separately to meet their connectivity requirements for leased-line and dedicated circuits external to the TMC. (These external connectivity needs are shown as the "clouds" of Figure 9.) The planned TMC wiring/cabling infrastructure was developed to include all connectivity from/to the signal entry panel in the TMC (Room B-09) and redistribute internal signals to/from the equipment Room 124, and then to Rooms 112,119, and 307 as needed. The variety of connections needed to be reduced to one of four media types:

- Unshielded twisted pair (UTP) Category (CAT) 5 for 10 Base-T network connections
- UTP CAT-3 for serial and analog phone quality connections
- RG-59 for video connections (lower quality)
- Shielded/grounded audio.

The initial installation contract was awarded to JHK & Associates in early January 1996. JHK's schedule was coordinated to avoid conflicts with continuing construction, ATMS system installation, and TMC occupancy inspection tours. JHK became our on-call-as-needed wiring support subcontractor. System-specific hardware-to-hardware, rack-to-rack wiring and cabling was assigned to the developer (e.g., TRW for FES, ATMS) or ISP teams (e.g., DCI, SkyTel, Maxwell Technologies). Except as noted below, the infrastructure wiring effort was completed without major problems:

- Several last minute changes and enhancements created a backlog in JHK's ability to respond efficiently. To solve this problem, the team did some of the wiring, using JHK and their subcontractor, TelSystems, only when there was time to accomplish the task or when the task involved connection to, or programming of, the TMC's Private Branch Exchange (PBX).

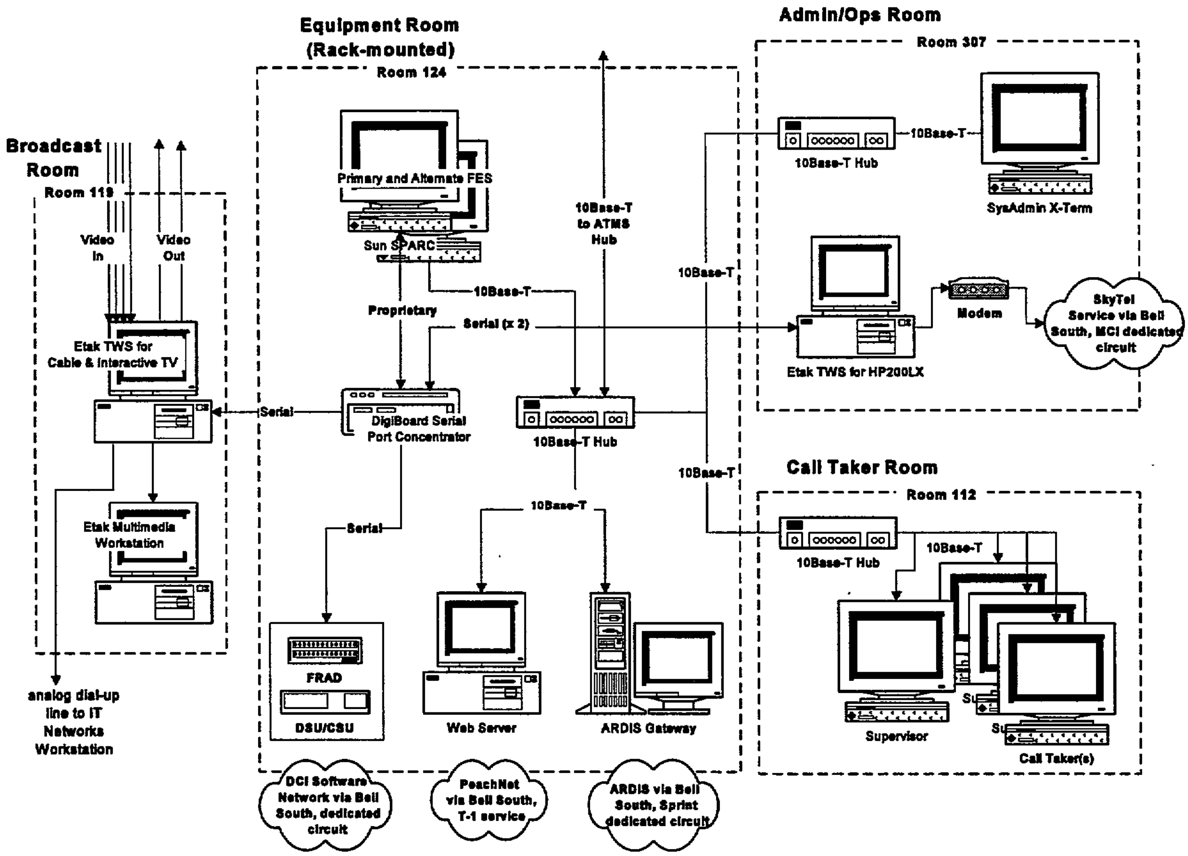

Figure 9. The integrated TIS was based on client-server architecture using a fixed-end server.

- The activation of public-access Internet service with real-time traffic from the rack-mounted Web server was significantly delayed due to administrative delays in placing an order for T-1 service. The team activated and hosted the Web site at the Maxwell Technologies development facility in San Diego, California, which precluded access to real-time traffic, so those Web pages were flagged as "Under Construction."

Fixed-End Server Installation, Integration, and Testing

This section addresses the general installation of the FES and its role as the baseline system for the TIS. A higher-level view of the FES installation in this integrated environment is shown in Figure 9. More specific detail on the architecture and connectivity of the FES to individual systems can be found in the section which follows, "Fixed-End Server." The installation, integration, and testing of the FES was planned to occur first, which would make the FES available as a stable integration and testing facility for the ISP systems as they completed development remotely, arrived, and were installed in the TMC. The FES was planned for arrival, installation, and completion of integration and testing (I&T) during the period January 12 to 15, 1996. Software bugs, incomplete functionality, misunderstanding of specifications, and delayed delivery of parts and components hampered and extended this period. The FES was actually installed and stabilized adequately by early February to begin using it to test other systems (e.g., the in-vehicle device was the first system).

There were also higher-level system integration testing requirements and scheduled events in mid-March 1996, for all systems in ITS Atlanta. To ensure interoperability and cooperation between ITS Atlanta systems, the TIS needed to pass several tests of joint external interfaces and operator interaction with ATMS. This initial formal testing event between TIS and ATMS on March 18,1996 was successful as far as it could go, because there were no operational surveillance sites or slow-scan cameras to be tested. Additional rigorous testing and demonstration rehearsals were required prior to the VIP tours and demonstrations which were planned for the GDOT TMC opening ceremony on April 11, 1996. This rehearsal testing also was completed without major functional problems.

All required TIS-to-ATMS functions and interactions were examined and worked properly, or the cause of not working was obvious (e.g., different mapping database versions). These inconsistencies and bugs were identified and solved as quickly as possible, and then verified to work. Other than schedule delays due to "normal" integration bugs and inconsistencies, the integration of TIS into the GDOT TMC, and with ATMS, went as smoothly as could be expected given the hectic schedule and concurrent, often competing activities. Notable problems and issues are summarized below:

- Integration and testing problems continued between the FES and ATMS through early April due to lagging software development and mapping database differences. The team focused more resources and attention on implementation of the remaining functional software on both sides of the TIS-ATMS interface (same staff at TRW working both sides).

- The TIS was using the January 1996 version of the Navtech' database, and the TMC was using a Navtech map database distributed in November 1994, which caused disagreements between the two systems that could not be resolved. GDOT worked with Navtech and obtained the current version of the Navtech mapping database, which ultimately resolved the mapping data incompatibility problem.

- The project experienced continuing interface and communications problems between the FES and MARTA servers throughout the operations period (through September 30,1996). Although the TIS was prepared to make the connection, MARTA and the TMC could not connect. The TIS itinerary planning software was implemented and ready for testing, but the MARTA and TIS servers were not able to connect reliably in time for success in the TIS operational demonstration period. This continuing problem was attributed to overall networking inconsistencies between the TMC and MARTA, and permissions between the FES and the MARTA "Ute" server (itinerary planning host).

Surveillance Subsystem fntegration and Test

The integration of the TIS surveillance sites began in March and continued through July 1996. Some additional sites were identified late, which extended installation past June 1, 1996. The challenges in integrating surveillance sites were developing interface software for radar site control and data acquisition, developing interface software for video site connection and control, bringing site(s) on line for integration and testing, and debugging of both TMC and site-hosted software. The first site was activated in April 1996, and testing began. Final integration and testing of the TIS radar and video sites was delayed because of construction and installation of power and telephone service, but accomplished in time for operations.

[7] The January 1996 Navtech database was free during the Showcase period. The TMS version of Navtech was a registered copy, and the last available version.

ISP Subsystems Installation, Integration, and Testing

Although the team established a schedule for all ISPs' arrival, installation, integration, and testing in the TMC, only one appeared on schedule. The other ISPs required schedule extensions and delays, including design and interface changes that affected their ability to integrate in the planned environment. This process was not surprising, however, because of the initial aggressive project schedule. Approximately two months of schedule reserve was planned in the first half of 1996. This scheduled time allowed for successful startup on June 1,1996. Table 4 summarizes the more significant difficulties and workarounds that were employed to bring the system together concurrently with continuing development.

Physical and Functional Configuration Audit

The testing team, which included SRC and Battelle staff, scheduled and conducted a physical and functional configuration audit (PCA/FCA) of all systems between March 25 and 28. During this process, the team physically inspected each system and each component in each system, and ensured that all were properly tagged for inventory purposes and that the physical configuration matched our understanding of the system. Very detailed annotated drawings of each system were created for the "as installed" implementation, and all core team and ISP teams were advised that no changes were to be made that were not coordinated and approved. The same procedure was followed for functionality with documentation of the positives and the negatives as deviations from the expected functionality expressed in the Functional Description Document (FDD), the Test and Evaluation Master Plan (TEMP), and several derived Test Procedure documents. Once again, the test team insisted that no changes be made to the demonstrated functionality unless coordinated, prioritized, and approved. This PCA/FCA event forced the ISPs and TRW to "deliver" and the project team was able to acquire hands-on information on the current status of the TIS systems and devices. All ISP subsystems were delivered to Atlanta on this date. Changes to hardware and software configurations and functionality continued as needed to meet the defined delivery schedule and TIS operational mission needs.

ITS Atlanta

Integration of TIS within ITS Atlanta created a need for much closer coordination between formerly dissociated projects. Three areas requiring significant attention included the need for interfacing software on ATMS, consistency of mapping database systems and roadway abstractions, and how to perform road closures consistently across systems.

It was readily apparent that TIS would need additional ATMS functionality to successfully integrate TIS surveillance resources, and then draw data from that system. For example, the ATMS virtual loop speed sensors were tied to mile posts; TIS required speed information related to road segments. This data conversion, mapping, and standardization task was accepted by the TIS team. Our team applied additional resources to the development of portable radar data acquisition and processing code to run on ATMS as well as the FES, and development of a more robust, database event-driven client-server interface between TIS and ATMS. This was accomplished using shared staff resources from the ATMS and TIS development teams and worked well.

TIS had independently chosen (before the ITS Atlanta integration decision) to use a roadway abstraction referred to as a "segment." A segment consisted of one or more Navtech links (or SIFIDs, an undefined Navtech term) and this segment was designed to represent a decision-point-to-decision-point piece of roadway (for example, from an entrance point to the freeway system to the next exit point of the freeway system). The baseline TRW TransView product, and all of the FES value-added

Table 4. The Showcase Team Faced a Number of Challenges in Integrating the ISP Subsystems

ISSUES	SOLUTIONS
Envoy/ARDIS	
■ During the period February through early June, the Envoy went through several software releases which made the integration effort very challenging; each new release required a quick regression check, specific test of the bugs that were reportedly fixed, then continuation of the integration and test process. ■ The communications path for the Envoy had three stages: (1) the initial connection to the ARDIS development switch was made via dial-up access, (2) then the connection migrated to a dedicated leased circuit, still on the development switch, and (3) finally, the connection was moved to the ARDIS production switch and testing was completed. ■ Most of the problems encountered with the I&T of the Envoy and ARDIS were with the ARDIS Gateway Server. This PC was designed to be. the "mailman" between the ARDIS network and the FES using TRW-developed code and a pre-certified commercial off-the-shelf ARDIS-compliant package named RFGate from NetTech Systems. The "mailman" code proved to be more complex, which caused several delays in I&T. Several verified bugs in MS Windows NT (e.g., memory leaks) affected the stability of the message-handling process.	TRW removed and disabled the extra functionality in the message processing code, which greatly improved the reliability of the system. MS Windows NT Service Pack was installed, with bug fixes which virtually eliminated any further problems.
HP200LX/SkyTel	
■ The start of the HP200LX integration process was delayed until completion of the TMC wiring. Once this wiring was installed, a connection to the SkyTel network (Jackson, MS) was made via modem and dial-up access, and testing of the basic communications interactions between the HP2OOLX and the TWS were enabled and successful. The connection then migrated to a dedicated leased circuit and was regression tested as functional. ■ The majority of the problems encountered with the I&T of the HP2OOLX and SkyTel components were software and interface related. Most significant were the divergences from specification in the Landline Data System (LDS) interface. The project team corrected the divergences and the Interface Control Document (ICD) was revised to keeo pace with the corrections.	TRW modiied their server side of the LDS interface and ETAK modiied their client side. Onsite debugging and development teams solved their three-tiered client-server I&T issues interactively where possible. In the three-tiered client-server architecture, the HP2OOLX client talked to the TWS, and the TWS talked to the FES. This architecture works best when many clients ask essentially the same questions (e.g., Traffic Now). The TWS, or second tier, acts as the traffic situation repository to share with multiple clients, which miniies the need for repeated queries of the higher-level server,

Table 4. The Showcase Team Faced a Number of Challenges in Integrating the ISP Subsystems (continued)

[redacted]	[redacted]
Siemens/Zexel	
■ In-vehicle I&T began in early February 1996, but was limited to verification and testing of the Siemens device's inherent functionality until the TMC wiring was completed. Once the TMC wiring was completed and a basic dial-up connection was made to the DCI software network, final I&T commenced using data generation scripts to load and vary a simulated traffic situation in the FES. ■ The majority of the challenges encountered with the I&T of the Siemens/Zexel in-vehicle system were related to the number of companies and people involved. Determining the location of a potential problem and troubleshooting these issues in near-real-time was difficult because of time zone differences. No single communications subcontractor had the responsibility or scope for end-to-end connectivity. Additional challenges were introduced by the geographic diversity of the team: DCI handled the Frame Relay Access Device (FRAD) and the software network from California; Racal (local) handled the DSU/CSU and WRFG (a local college radio station), Cable and Wireless were located in California; Bell South (local), Sprint (local), and TRW developed the software on the FES in both Atlanta and California. All the communications devices and services were installed in the TMC while the responsible technical contacts were nationwide.	A dial-up line to the radio station was established so that testing of the basic broadcast communications between the TIS in the TMC and the in-vehicle units were enabled. Later in this process, the connection migrated to a dedicated leased circuit, and testing between the TIS and the in-vehicle units continued. An in-vehicle desktop unit was constructed for in-house test facilitation, quality checks, and demonstration purposes; this unit was a complete vehicular system without the GPS capability.
ETAK Cable Telephone Systems	
■ The initial suite. of cable TV system equipment arrived and was installed in March; initial I&T was limited to verification and observation of the functionality of the system at the source (e.g., no facility to broadcast the cable TV program). There were many issues and revisions in the cosmetic appearance of the maps and graphics displayed by the system which were operational suitability issues, not integration issues. Additionally, there was an incorrect assumption that the cable TV program "composite video" signal would include both video and audio, but this was not the case.	Additional wiring was added to carry the audio portion of the program from Room 119 to Room 124, the equipment room, then two audio channels were allocated on the fiber to GPTV.
■ Subsequent to completion of I&T, the project team decided to extend the cable program (composite video and audio output) to several city and county destinations via existing fiber optic connections. This capability would be used to replace the Georgia Public Television (GPTV) service via satellite with the existing fiber links following the Showcase period. GPTV long-term was considered to be too expensive. ■ Aside from the dynamics of TMC wiring and cable program appearances, the majority of the more serious problems encountered with the I&T of the ETAK cable TV system were due to incipient bugs and glitches in the software on the TWS, the multimedia machine, and the interactions between the multimedia machine and its peripheral devices (e.g., V-LAN, video/audio mixer, COD1 board).	This enhancement required the purchase and installation of audio and video amplifiers, audio encoders and decoders, installations in the TMC and destinations at the City of Atlanta, and Clayton and Gwiunett counties. Significant wiring additions were made to the TMC by Battelle/SRC to accommodate the new equipment to improve system reliability. Another set of wiring additions were needed to connect the cable TV video and audio to the MediaOne cable TV service rack in TMC B-09. MediaOne is a local cable television provider that was given a direct feed of the TIS cable television program over their own fiber connections to the TMC. When the new wiring, amplifiers, and encoders were put on line, it was necessary to fme tune the audio and video levels. We hired a local TV station engineer was hired for this task to minimize the engineering time.

Table 4. The Showcase Team Faced a Number of Challenges in Integrating the ISP Subsystems (continued)

ISSUES	SOLUTIONS
Source Media Interactive Television System	
This system was external to the TMC and closely managed by Source Media. It connected through a single dial-up telephone line to the traffic data stream from the ETAK cable TV system TWS in Room 119.	Because it was external to the TMC facility, closely managed by Source Media. It was never fully integrated with the other component systems and, therefore, was not a significant I&T issue.
Maxwell Technologies Web Site/Home Page	
▪ The initial system arrived in the TMC in March 1996, and was installed with prototype ".html" pages, with no live connection to the network or FES. There was a significant setback in this development and I&T effort when there was a negotiated but uncoordinated change in the Message Session Based Client (MSBC) interface. The two components, TRW and Fastline Traffic/AlIpen (Envoy Team), did not request authority to change, nor did they publicize those changes until a February design review. This change was a technically correct choice but affected the Web site development team, and was an additional cost to the project. In May, we made a second well-publicized and significant revision to the MSBC to create two versions: a new derivative that was bit-oriented for use by wireless systems, while the basic character-oriented MSBC remained essentially the same for use by directly connected systems. The Web site was the latter so this change had minimum effect on their development process.	We worked to ensure that key players participated in interface change management and control. We took active measures to ensure that current data tables were disseminated regularly with sufficient official fanfare to alert development teams.
▪ In late March, a decision was made in the ITS Atlanta forum that the TIS Web site would be installed in the TMC and would be connected to PeachNet for Internet access, and would share resources with the GDOT Web site (under development). The project team agreed to purchase all the initial hardware and pay for the T-l installation and initial months of service. This process was initiated in late March, encountered significant administrative and equipment delivery delays, and was completed in late June with installation of the Internet service. Once the T- 1 service was installed, the Web site was on line as "httpj/www.georgia-traveler.com" with live data.	The TIS team coordinated with GDOT for the installation of the T-I service in the TMC.

software, was developed to work at this level of abstraction. It was necessary for TIS to include a mapping of ATMS incidents associated with Navtech links to TIS abstracted segments. TIS also expected all speed data to be associated with a segment. This was easily accomplished because TIS developed that speed processing software for ATMS. Because TIS was developing the code for speed conversions, our team accepted the task of ensuring TIS segment and Navtech link agreement across all ITS Atlanta systems. This reduced to development and dissemination of a location table which could be used to map one way or the other.

During our first system-level TIS test with ATMS, it was discovered that ATMS was using an obsolete Navtech mapping database. This caused many of the geo-located incident reports from ATMS to generate unknown link ID errors in TIS. This mapping data mismatch would prevent a successful TIS-ATMS data-sharing interface. This issue was elevated to the ITS Atlanta forum, and was resolved by GDOT installation of the newer version.

Operations Begin

TIS operations began on June 1,1996. It was soon apparent that TIS would be used to supplement ATMS speed data in the absence of the Autoscope^{TM} virtual loop system.' TIS developers took steps to enhance the FES Call Taker and Supervisor graphical user interfaces (GUI) to facilitate the additional workload required to supplement ATMS speed data for the benefit of ATMS, Kiosk, and ADAS systems. Throughout the entire operations period, TIS operated in the "'failover" mode[9] in that TIS acquired all the available speed data from TIS radar sites, and by Call-Taker manual entry based on roadway video browsing, Metro Networks data terminal, and roving spotter call in.

LESSONS LEARNED

Several key issues emerged from the Showcase systems integration activities:

- **The "host" installation (in this case, the FES) must be kept on track ahead of the "clients" (e.g., applies to FES compared to ISPs) to facilitate these client ISP systems having access to a stable "host architecture" for their final integration and test phases.** This also applies to having a stable ATMS or MARTA server for FES testing. Schedules for server installation, integration and test, and stabilized operations should precede the use of ISP systems by four to six months. That was not possible in this case, but is a good goal.

- **Verbal agreements on availability of resources and facilities proved unreliable.** When such agreements are made, they should be documented in writing and then distributed to all agreement partners, (for action) to all directly affected parties, and (for information) to the remaining project team.

- **Although ultimately successful through flexibility, adaptation, and long hours, this project proves, once again, that things just do not happen on schedule as planned.** In this case, office telephone service, delays in infrastructure wiring, furniture delivery delays, verbal agreements gone bad, multiple competing priorities, mismatched databases, and external integration difficulties presented problems to be resolved. A complex project (e.g., multiple vendors and subcontractors, diverse geo-locations) must keep a schedule management reserve, and must have several alternative plans based on the assumption that anything can go wrong at any time.

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[8] The AutoscopeTM automated surveillance system was scheduled to be available for I-75 and I-85 during the TIS operational period. Due to technical difficulties the data were not available until November, 1996.

[9] "Failover" mode is defined as a set of pre-planned steps for degraded operations, focused on TIS acquisition of supplemental data not available from ATMS. For example, if ATMS were unable to acquire speed data from Autoscope^{TM}s, TIS had manual data entry screens that could be used to replace or supplement this missing information. TIS also had the capability to control and access the 51 TIS radar or 22 video surveillance sites directly, or to allow ATMS that privilege.

Fixed-End Server

Fixed-End Server

The Traveler Information Showcase (TIS) fixed-end server subsystem provided the hardware and software components necessary for the required connectivity and functionality for information processing and dissemination to a variety of TIS users.

OBJECTIVE

The goal of the fixed-end (FES) server activities was to design, build, evaluate, install, operate, and maintain a fixed-end server which would be the "host" server for all data repositories and communications connectivity specific to the TIS.

APPROACH

The project team decided to use an off-the-shelf baseline product called TransView in order to minimize the designing and building of the FES. TransView was a TRW Sunnyvale internal research and development (IR&D) product and was an "in kind" contribution to the TIS effort. The goal was to enhance TransView with TIS "value-added" functionality in an accelerated development methodology as outlined in the following:

- Use TRW's TIS/TransView as the product and functional baseline
- Rapidly define external interfaces (input and output); concurrently order hardware and software; begin design/build work of the value-added functionality
- Get the emerging proto-FES on line as soon as possible-preceding other systems so it could be the "host" for concurrent ISP and other external interface testing
- Minimize formal design documentation efforts; rely heavily on TRW software development teams, TransView specialists, and transportation domain expertise in Atlanta to partition the work (e.g., TRW teams also were developing ATMS and MARTA systems in ITS Atlanta)
- Following successful completion of the FES task, complete the "as-built" documentation for use in legacy.

Alternatives Considered

Very few alternatives were considered because the FES development needed to occur within a compressed schedule. Issues that were addressed include the following:

- **Operational.** Should the FES be located at the TMC in the equipment room, in Room 307, at TRW's Atlanta facility, or in the Battelle Peachtree office? Should the FES include more functionality to assume a part of the role of the ATMS? Should the FES make provisions to share data more widely and freely with other ITS Atlanta systems (e.g., MARTA, Kiosk, ADAS) in case of partial or total ATMS system failures?

- Technical. Which options made the most sense for the external interface given the emerging output ISP systems (e.g., a textual/dial-up landline data system, a custom-built message interface for wireless systems, a broadcast data stream for in-vehicle systems)? What should be the flow management processes for external interfaces (e.g., polling, push/pull data, on exception/change, dedicated connection, dial-up, high-speed links, message-based interactive session)?

- Programmatic. Should the TransView Sunnyvale team relocate to Atlanta to resolve coordination problems?

Alternatives Selected

After considering the various alternatives, the project team agreed to the following:

- The FES would be rack mounted in the TMC equipment room, and all ISP systems would connect there for data flows. This location was logical for operational and legacy uses (see Figure 10 and Figure 5).

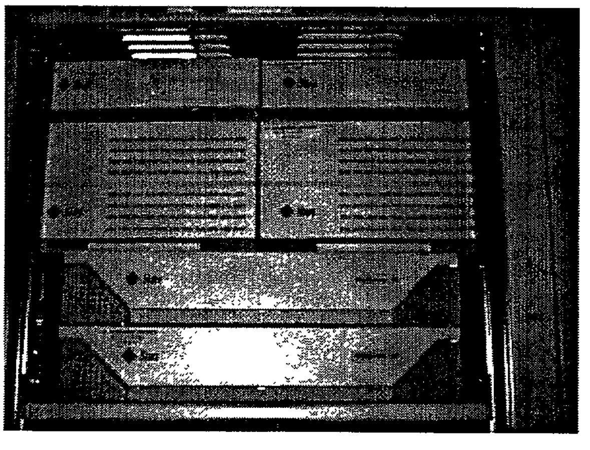


Figure 10. The team decided to rack mount the FES in the TMC equipment room.

- Examining ISP system and device capabilities resulted in specifying the best external interfaces:
  - TransView's landline data system (enhanced) for the FES to the ETAK Transportation Workstation Server (TWS) for the HP2OOLX and for the FES to the ETAK TWS for cable TV and interactive TV systems
  - Custom-built User Datagram Protocol (UDP) and Bearer Access Protocol (BAP) for the DCI and Siemens/Zexel in-vehicle system
  - Custom-built Message Session Based Client (MSBC) interface for the Envoy using the ARDIS wireless system and for the Web server using a 10Base-T network connection
  - Custom-built Structural Query Language (SQL) triggers/processes for the alert-then-query/response FES to ATMS interface and custom-built query and parsing routine for the query/response FES to MARTA interface
  - Custom-built dial-up modem-driver control interface module for the FES-to-radar surveillance sites for radar-site control and data acquisition and a custom-built video control interface module to TIS slow-scan video sites for site selection, video-to-decoder selection, and camera control.

- The TRW TIS team would develop "portable" code that would run on either FES or ATMS to control TIS surveillance sites and acquire and store speed data from radars or Call-Taker input, and the FES would "behave" like a single Kiosk in making itinerary planning requests from ITS MARTA server

- The FES would include all graphical user interface (GUI) tools for Call Takers to enter and control information. This was modified and enhanced later to include additional "failover" functionality when it was announced that ATMS would not have reliable Autoscope™ virtual loop speed data available during the TIS operational period

- Choose the best approach for data based on what made sense (e.g., wireless systems should store more data locally/statically to reduce cost of wireless communications; directly connected systems or flat-rate costed systems could choose to have data feed via wireless, metallic, or network connection paths with minimum local/static data store).

IMPLEMENTAWON

The FES development effort began in June 1995, and proceeded rapidly through analysis and initial design. The TRW Sunnyvale team focused on enhancing TransView, and the Atlanta team focused on coordinating and interacting with other ITS Atlanta projects for input interfaces (e.g., ATMS to FES, MARTA to FES, and Call Taker GUIs), and the region-specific database and operational aspects (e.g., Navtech mapping data, implementation of ATMS policies).

The Sunnyvale team also was responsible for close coordination and technical interchange with the ISP developers located in that vicinity (e.g., Fastline Traffic/Allpen for the Envoy, ETAK and HP for the HP2OOLX and for cable and interactive TV systems, Siemens for the in-vehicle units, and Maxwell Technologies [San Diego] for the Web page). These roles worked well early in the project (June 1995 to December 1995), but began to be too complex and burdensome as the product neared completion. This increasing complexity occurred concurrently with the ISP's need for extensive test time with the FES and TRW's need for exclusive use of the development labs and FES facility for final implementation.

External Interfaces

The focus of the actual value-added development effort was on implementation of the external interfaces. There were four external interfaces developed or enhanced: (new) the ATMS Interface (ATIF), (enhanced) TransView Landline Data System (LDS), (new) UDP/BAP, and (new) MSBC for Envoy and Web server. All interfaces were initially developed and unit tested by TRW Sunnyvale; bug fixes, final revisions, and enhancements were completed by TRW Atlanta as part of final integration and testing (I&T) and as functional or performance discrepancies were noted in testing and evaluation (T&E).

ATMS Interface. The TIS team developed the new ATIF to ATMS, which minimized interference with TRW's progress in completing ATMS. This interface is essentially a logical connection through the ATMS/TMC network operating at 10 Base-T speed. Its simplified functionality is summarized as follows and as illustrated in the flow diagram in Figure 11:

- ATMS acquires all traffic situation data (speed, incidents)

- A database change causes a "trigger" to the TIS code on ATMS

- The FES queries ATMS to ask "what changed"

- ATMS responds with a "list"

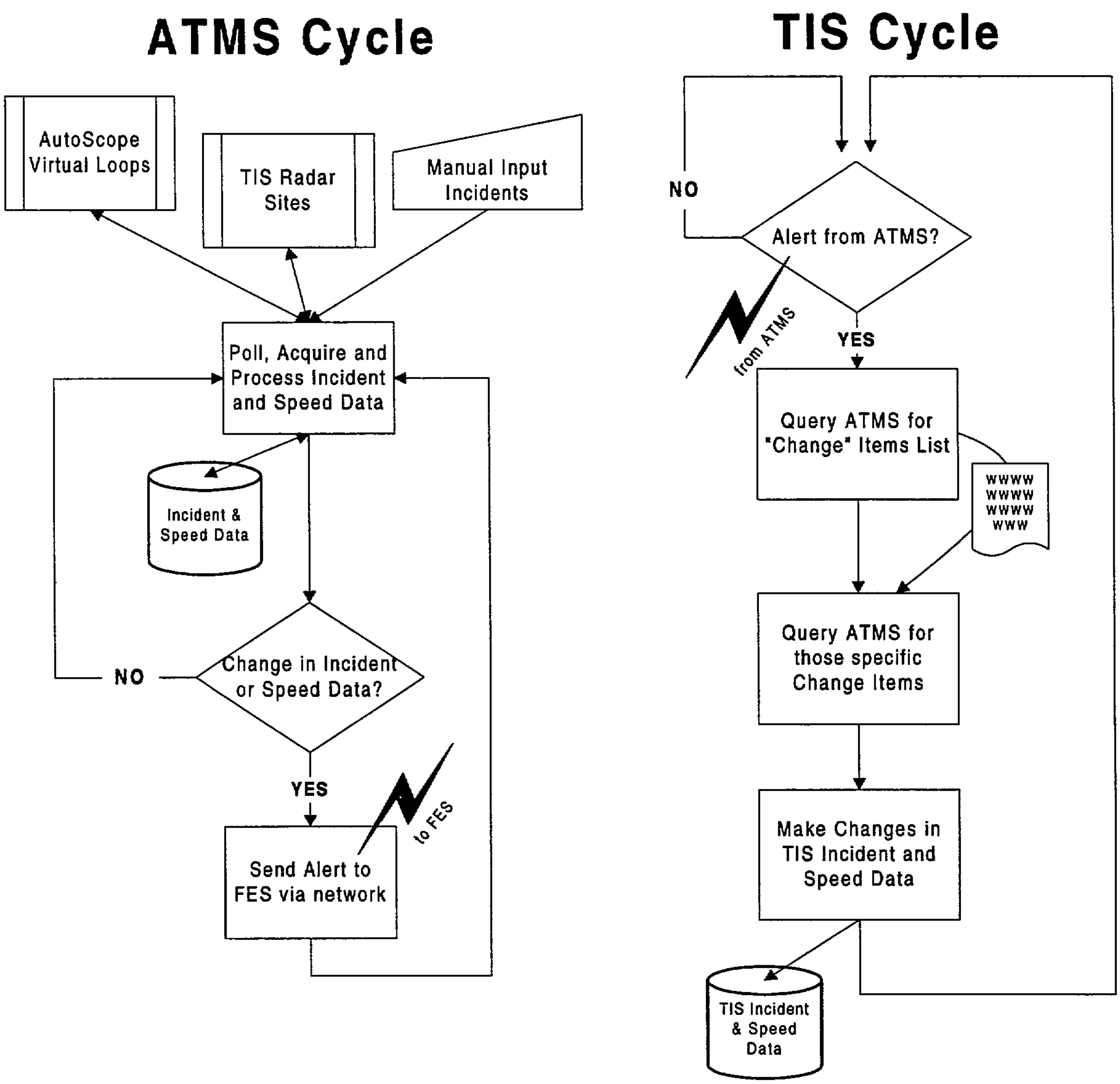


Figure 11. ATMS–FES ATIF simplified flow diagram.

- FES then issues only those specific queries for the data that changed
- FES updates TIS unique data tables for subsequent dissemination to ISPs via the several external output interfaces.

The only exception to this "normal" flow is during full or partial failover operations when the FES is controlling and acquiring radar data from TIS sites, or when the FES is collecting speed data through manual data entry by an Operator/Call Taker. (Collecting incident data is irrelevant as it is a GDOT operational policy that TIS does not provide this data to ATMS via the ATIF.) To minimize the impact of failover operations on ATMS, the sequence of events for supplementing ATMS speed data is the FES acquires the speed data, gives it to the ATMS (by direct database entry over the network), and the ATMS "thinks" it caused a change and triggers the ATIF process as above.

TransView Landline Data System (LDS). The LDS interface was included in the TransView baseline product but was strictly output oriented, not interactive. This interactivity was needed for the TIS FES application to implement the collection of parameters in the processing of client-server requests for route planning or transit itinerary planning. The TIS project also enhanced several of the TransView databases and made them available via the LDS interface (e.g., points of interest, yellow pages, Olympic and commercial parking lots). The advantages are that LDS is easy to connect, easy to use, and output is both human-readable and easily parsable by an ISP client system. A specific description of all the LDS capabilities and features can be found in the LDS ICD (provided as an appendix to this document, under separate cover). A general description of design and use follows and is illustrated in Figure 12:

- Designed for use as either a dial-up or direct serial connection
- Keyboard text menu-driven or client “firehose” modes
- Responds with par-sable textual data or parsable data file transfer[9]
- For menu-driven use by a terminal, the LDS interface presents menu choices at ever-increasing levels of detail until the data file is reached, then sends that file to the user
- The “fiiehose” mode is designed for use primarily with a client system that is then an ISP server; LDS and its menu-driven or “firehose” modes work generally as follows:
  - Client (ISP or human operator) connects, logs in with USERID and PASSWORD
  - Client sends a textual string request for menu item or file "D"ump of relevant data (e.g., speed, incidents)
  - Client continues menu navigation or (firehose) issues textual string request for “U”pdate of same files
  - FES now monitors those files and sends them to client only when they change
  - FES LDS stays connected in firehose mode until the client breaks the connection or the human logs out with a “Q” (Quit) command.

User Datagram Protocol/Bear Access Protocol (UPD/BAP). The UDP/BAP method was chosen for conformance with the emerging national ITS architecture. UDP is a computer operating system term for messages broadcast without acknowledgment, and BAP is a term for the message wrappings placed around the payload to describe destination, origin, and payload size within the network. Specific information on the UDP/BAP implementation for TIS can be found in the In-Vehicle System ICD (provided under separate cover as an appendix to this document). In general, the message payload was encoded with International Traveler Information Interchange Standard (ITIS) codes to indicate the data type (e.g., speed, incident), location (by TIS road segment), and value (e.g., mph, incident impact code) for that data type.

9 The LDS “parsable” data is both human-readable and yet structured with keywords and formatting rules so that client software can easily locate textual data elements for use in a database. Please refer to the LDS ICD (provided as an appendix to this document) for specific examples.

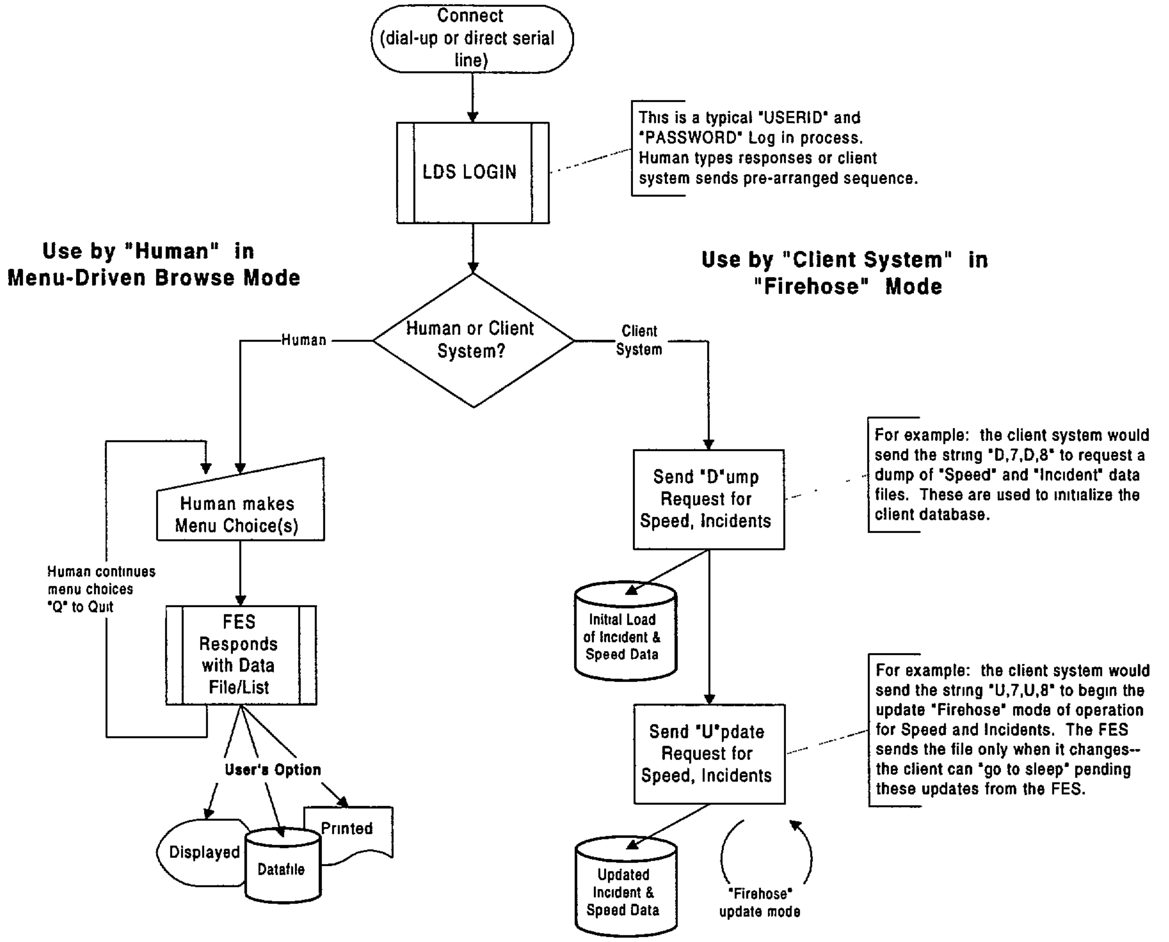


Figure 12. LDS interface flow description.

Message Session Based Client (MSBC). The premise of the MSBC interface design was one of a discrete client-server session with an interactive request-response dialogue. In the case of the TIS FES application, there were two clients: the Motorola Envoy via ARDIS and the Internet via a Maxwell Technologies Web site. More specific information about the MSBC can be found in the MSBC ICD (provided as an appendix to this document). The following describes the MSBC, and Figure 13 illustrates its operation:

- MSBC was used to interface with the Motorola Envoy via the ARDIS wireless network and with the Web server via the TIS 10Base-T subnetwork hub
- A session was initiated by a LOGIN request; up to 10 user sessions could be active simultaneously but requests and responses were received/sent serially through ARDIS
- A session was terminated by a LOGOUT, or timed out by the FES after no requests in a tunable period (e.g., 5 min, 10 min)

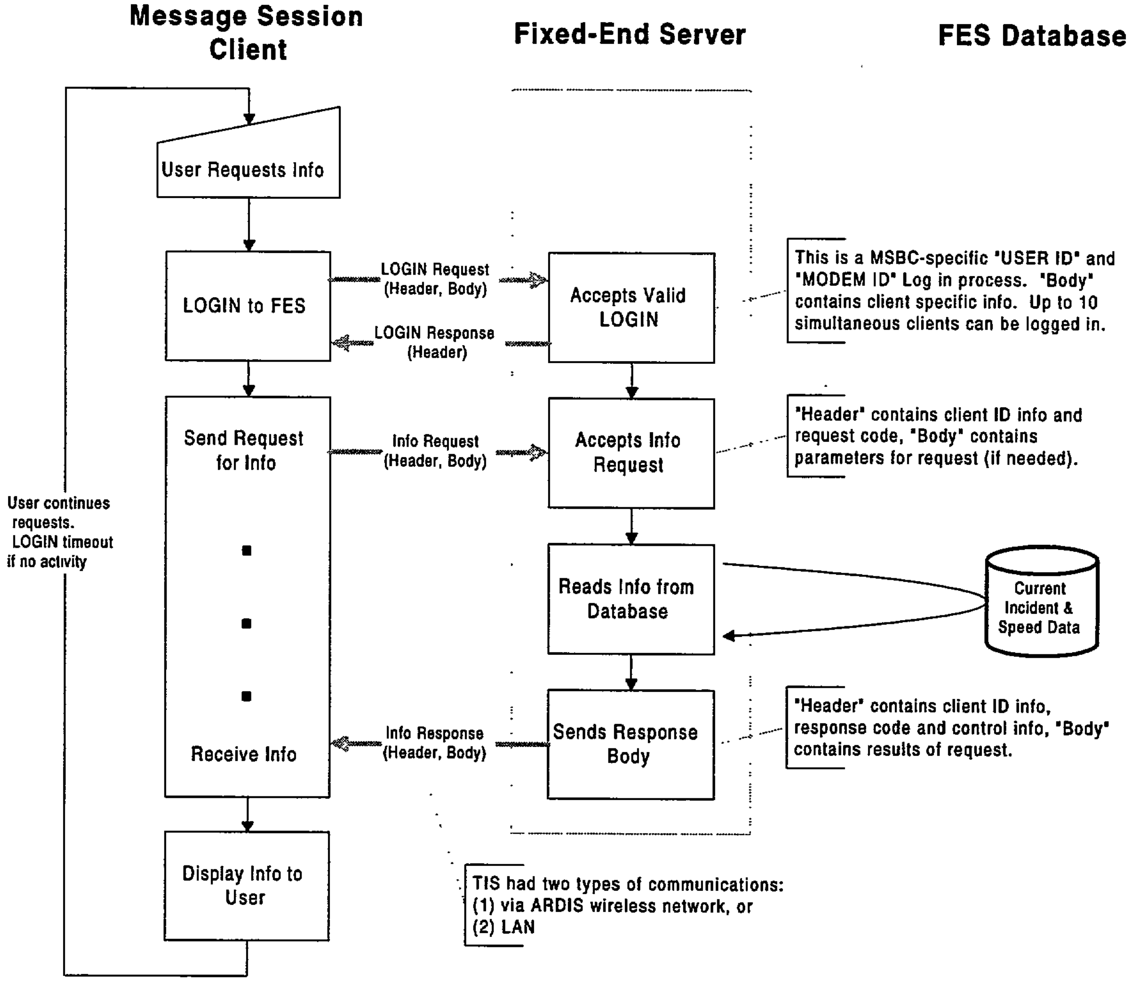


Figure 13. MSBC interface flow diagram.

- Both client requests and server responses contained bit or character-coded information which required interpretation by the client device (e.g., road segment IDs, road name codes, ITIS codes)

- A specialized version of several MSBC messages were designed as bit-oriented for use by the Envoy; these contained bit-encoded data blocks to minimize ARDIS wireless costs (e.g., 200 individual speed reports were represented in 50 bytes as sequences of 2-bits each).

As FES development progressed, it became necessary to baseline the TransView-enhanced product and centralize it in Atlanta. This baseline Showcase 1.0 (SC1.0) was transferred in late January 1996, and began initial installation and I&T in the TMC. Work on the final version continued in California. A few functional shortcomings required additional development effort to complete, but the FES product was ready for initial I&T in late January 1996. Additional debugging and enhancements continued through June 1996. Finalization of upgrade work and ISP interface testing continued in California through early March, concurrently with the installation, I&T, and initial T&E of the baseline in Atlanta.

As the team neared completion of the FES, a controlled environment was needed to focus on resolving functional bugs and glitches. Consequently, it was necessary to restrict access by ISP systems, which created problems and challenges for the ISPs who faced difficulty completing their unit testing and debugging. The FES was often not available for dial-in or TRW laboratory access in Sunnyvale. In Atlanta, systems installed in the TMC on schedule (e.g., Siemens in-vehicle system, ETAK/HP200LX completed their I&T through closer coordination with the onsite TRW development team.

Our project team had not planned on ATMS or MARTA being available during early I&T, so we planned an alternative means of generating traffic data through automatic scripting and simulation. We began this process in mid February so that ISP systems in Atlanta could begin to see simulated data flows for their final I&T. This worked quite well for systems co-located, as the in-vehicle system and the ETAK TWS for the HP200LX. It also worked for external ISPs, but it was often challenging to ensure that the Atlanta FES was available for dial-in use from the West Coast ISP developer teams. The time difference allowed three to four uninterrupted hours in the morning of the East Coast day, but Pacific time developers often had problems at night when Eastern zone developers were not available for consultation, debugging, or crashed system restart. The times in between were often quite hectic as multiple competing priorities (e.g., development and test concurrent with client user debugging) kept everyone busy.

As the FES product stabilized in early March, delays in ATMS I&T and in its availability began to have an impact. The MARTA interface also was not available, and eventually never was useable or reliable for the intended TIS itinerary planning functionality. The FES passed the higher level I&T with ATMS in mid March, and was ready for the GDOT TMC Grand Opening-Ribbon Cutting ceremony, VIP tours, and demonstrations on April 11,1996.

The final FES enhancements and continuing bug fixes continued from mid April through May 1996. In mid May, the team decided that a major revision to the MSBC interface was needed to save money in the use of the ARDIS wireless network. This revision created two versions of the interface: one remained character-oriented and was for use by directly connected ISP systems (e.g., network or dedicated media); the other was made bit-oriented to compress several message payloads for ISP systems using more costly wireless communications media. While other message elements remained constant, the encoding of certain message payloads necessitated a moderate revision in the Envoy client software, a risky-but successful-endeavor so close to the start of operations.

As mentioned earlier, the ISP systems needed the FES as a host and time to complete their development and unit test processes. In late April, the FES needed time with the ISP systems to verify completeness of the interface implementations and the performance of the FES in a more representative operational environment with competing devices and client systems. The unavailability of all ISP component systems in final form delayed the final I&T and T&E of the FES, so the flexible T&E plan was changed to avoid delays in FES “certification;” that is, the team abandoned the idea of “formal” FES testing and conducted “functional verification” and rapid regression testing. This approach was feasible because the FES would have full-time maintenance support during the operational period.

The official scheduled delivery date for the FES (and all other systems) was December 3 1,1995. In retrospect, the FES “system” was not actually “delivered,” but continued its evolution with development and hands-on operational support by the TRW development team through early 1996, through the ITS Atlanta I&T period March to April, and through the operations period June through September. To reduce the risk of system malfunction during Olympic and Paralympic operations, we restricted changes to carefully managed bug fixes. Bug fixes, code enhancements, GUI changes, and new functionality were allowed during off hours, only when absolutely necessary, and only after extensive bench testing.

The single-most significant shortcoming of the entire FES development effort was the weakness in design and build, I&T, T&E, and subsequent operational problems with the ARDIS gateway server. This weakness was a constant source of Envoy/ARDIS system failure or lock up, and constantly threatened our service to Envoy users. The ARDIS gateway software was much too “feature rich;” it had enhanced functionality that was not needed and caused many system crashes until disabled or removed. Known bugs in the Windows NT operating system also caused problems and delays.

LESSONS LEARNED

Several lessons learned emerged from the fixed-end server development process:

- **Always have the “server” or “host” on line well before any of the external systems.** Having the server in place facilitates unit test, I&T, and T&E of those external systems in a stable and pristine environment without loss of service due to concurrent changes (e.g., LDS “evolving” on both FES and TWS, the MSBC changing to meet needs of Envoy while Web server was beginning their unit test and I&T).

- **Minimize discretionary changes in the project team once the effort is under way.** Changes interrupt continuity and affects the outcome. Ensure that all development staff are “journeyman” caliber, and ensure that staff have a firm grasp of project/task, scope/schedule priorities, an effective means of team leadership/management, and control across project and geographical boundaries.

- **Ensure the compatibility of laboratory, development, and operational environments and operating systems (e.g., similar but not identical operating systems such as Sun OS and Solaris).** Avoid the use of untested/untried “buggy” commercial operating systems or off-the-shelf technologies in mission-critical paths (e.g., Windows NT as OS for ARDIS Gateway).

- **Invest extra resources (e.g., time and dollars) to construct a prototype test bed or breadboard of the goal system to discover and fii any design or operational interface flaws before going on line.** For example, the team waited until moving into the TMC to try external interfaces, connect DigiBoards (serial port concentrators), connect FES to the ARDIS PC, connect FES to ATMS, and connect FES to surveillance site “box.”

- **Defer some design documentation if necessary, but do not eliminate it.** Use MIL-STD, Institute of Electrical and Electronics Engineers (IEEE), or a tailored format as binding requirements unless the developer has a published methodology with acceptable documentation requirements and formats (with examples provided at the beginning of the process). Interface control documents (ICDs) are essential, and they need to be drafted early in the project and then managed carefully as they evolve to the as-built “solution.” A common documentation review capability will ensure that documents are completed.

- **Establish a common point for data configuration management and control.** It is essential in a TIS client-server, two- or three-tiered architecture that all systems and components operate off the same data baseline (e.g., delays were encountered due to incompatible data sets and different versions of the same data set, such as Navtech data and segment and intersection location tables).

Surveillance and Data Collection

Surveillance and Data Collection

For the various Showcase end-user technologies to have maximum utility and to demonstrate fully their respective capabilities, accurate and real-time indicators of traffic flow were needed. Furthermore, to provide useful traveler information to a broad segment of the population, Showcase surveillance information needed to be gathered from a large geographic area. The vastness of the area to be covered presented the greatest challenge of the entire project.

OBJECTIVE

From the outset, the Showcase Project Team agreed that design of the automated surveillance sites should meet five criteria:

- Information gathered should be directly applicable to and understandable by the end users
- Innovation and reliability should influence the equipment selection process, with reliability being the more important of the two
- Automated sites should be economical to stretch available funding as far as possible
- Equipment installed should have long-term utility for the Georgia Department of Transportation (GDOT)
- Field surveillance equipment should be easily transferable to other sites by GDOT at the close of the Showcase project.

APPROACH

The surveillance and data collection aspect of the Atlanta TIS began with team members contacting all transportation-related agencies in the five-county metropolitan Atlanta area. The purpose of these contacts was twofold: to gather available Olympic transportation information to aid future decisions, and to determine what surveillance facilities were already in place (or would be in place in time for the Olympics). Agencies contacted included GDOT, the Atlanta Committee for the Olympic Games (ACOG), the Atlanta Regional Commission (ARC), the City of Atlanta, the City of Marietta, and the five metro counties of Fulton, Cobb, Gwinnett, DeKalb, and Clayton. Contacts also were established with the two traffic reporting services in the Atlanta area, Metro Traffic and TrafficScan. These conversations were held to determine the extent to which these companies would be interested in providing “spotter” surveillance and at what cost to the project.

Assessing geographic needs was the next step. Using information from GDOT and ACOG, the project team identified candidate areas for Showcase surveillance. These areas included the Perimeter highway (I-285), radial Interstate routes, major routes serving remote Olympic venues, and locations expected to attract large volumes of spectator traffic such as MARTA bus and rail station lots, and interchanges providing access to Olympic park & ride lots. From this assessment, nearly 80 preliminary sites were identified. Anticipating that available funding would not permit all 80 sites to be instrumented, the team developed a procedure to set priorities for the sites. Factors considered in evaluating the sites included roadway classification, traffic volume, and proximity to venues.

While the candidate sites were being determined, a parallel effort was being performed to define the capabilities of the automated equipment sites. Showcase team member JHK & Associates had experience in designing a significant number of traffic control systems and freeway management systems. These system designs called for many different traffic surveillance devices to address various project needs. To capitalize on the experiences from these projects, engineers who worked on these projects were called upon to lend their collective professional opinions about the type of information and equipment that would best satisfy the automated Showcase surveillance criteria. Also, very early in the project, GDOT had been asked by FHWA to identify locations and types of equipment that would serve as a legacy and a foundation on which to extend the limits of the ATMS. This list indicated clearly GDOT's interest in video surveillance. Therefore, surveillance-site design took two paths-sites to gather traffic data only and sites to gather traffic data and to provide video.

Altematives Considered (Automated Surveillance)

The Showcase team was aware of several technologies available for measuring or monitoring traffic flow information. Many technologies had been thoroughly tested and were operational in numerous locations across the country, while others were still undergoing evaluation. Some were intended for use in measuring only one or two traffic characteristics, and others were designed to collect three or more, with a proportional increase in cost. Of the potential traffic characteristics that could be presented to the motoring public as a measure of flow quality, the team decided that travel speed would be the best. The average motorist does not relate to traffic volume or occupancy, but can relate to speed. For example, if the motorist's route is moving at 25 mph when it normally moves at 55 mph, the motorist can make a more informed decision about travel mode, time, and route.

The detection technologies evaluated included the following:

- Inductive loops
- Magnetic detectors
- Self-powered detector
- Doppler radar
- Presence detector
- Ultrasonic detectors
- Infrared detector
- Passive acoustic
- Video image detection
- Closed-circuit television.

With varying hardware, software, and communications requirements, the Showcase project could not employ each of the surveillance technologies identified. Selecting the technology to use required determining criteria to evaluate the detection technologies, and measuring that the criteria were consistent with the overall objectives: usefulness of information, innovation, reliability, cost, legacy value, ease of installation, and ease of relocation. The various technologies were scored according to the degree to which they met each criteria

Alternatives Selected (Automated Surveillance)

Two surveillance technologies stood out as having the best combination of useful information, innovation, reliability, economy, long-term utility, and ease of relocation: Doppler radar and closed-circuit television (CCTV). In fact, these two technologies complement each other. Therefore, the evaluation team recommended that a typical automated surveillance site consist of a color video camera with full pan-tilt-zoom capability and two Doppler radars, each sensing a different direction of travel.

These devices would be mounted along the side of the roadway on the same pole and strategically positioned to give both optimal speed surveillance and video coverage. However, in an effort to extend available funding as far as possible, installing both a camera and radars at every site was not necessary. Instead, the evaluation team recommended that selected sites be equipped with radar units only.

By having selected video surveillance as one of the two technologies, one major decision that needed to be made was which communication method would be used to transmit CCTV images back to the TMC. With a limited budget and a tight implementation schedule, the higher-priced methods (e.g., fiber optic cable, leased T-l lines, ISDN) were ruled out in favor of standard voice/data grade, dial-up telephone lines. The bandwidth limitations of these standard telephone lines would not permit full-motion video; however, GDOT officials had indicated early on that a video "snapshot" of traffic conditions every 3 to 5 seconds was completely acceptable.

GDOT set priorities from the original list of 80 candidate sites identified during the geographic needs assessment, and GDOT also applied their knowledge of the locations to determine if radar detectors alone would be sufficient or if video surveillance also was needed. Applying equipment and construction cost estimates to the prioritized list completed the picture of how many surveillance sites could be installed for any given level of funding. In the end, a total of 5 1 automated surveillance sites were installed. Twenty-two sites consisted of radars plus CCTV cameras, while the remaining 29 were equipped with only radars. Figure 14 illustrates the selected site locations, and Table 5 lists the automated surveillance sites.

Alternatives Considered (Manual Surveillance)

From the very outset of the project, manual surveillance had been discussed as one method of gathering traffic flow and incident information. The team envisioned traffic "spotters," stationed at key interchanges and equipped with cellular telephones, who would report observed traffic conditions. For a number of reasons, including the personal safety of the spotters, this option was discounted early as being impractical.

The vast area to be covered required a much more effective means of gathering traffic information. Discussions were opened with the two aerial traffic reporting services in the Atlanta area-Metro Traffic and TrafficScan-which had recently joined forces under one corporate owner. The combined companies, called Metro Networks, had the experience and resources to provide the necessary information to the Showcase project.

Traffic incident and speed information was to be reported by Metro Networks and to include information of both recurring and non-recurring congestion, stalled vehicles, accidents, and lanes blocked (if any). Information reported was to be updated every 15 minutes during the peak periods (6 am to 9 am and 4 pm to 7 pm), no less than every 30 minutes during off-peak periods (9 am to 4 pm and 7 pm to 10 pm), and once an hour during overnight periods (10 pm to 6 am).

The proposed manual surveillance plan called for a phased effort that would begin on a limited scale, gradually building in scope and reaching its peak level of surveillance just prior to and throughout the Olympics. As Olympic competition concluded, Metro Networks' area of coverage was adjusted to accommodate the Paralympics. Following the Paralympics, Metro Networks' workload concluded, with one minor exception. A computer terminal installed at the TMC to relay information from their

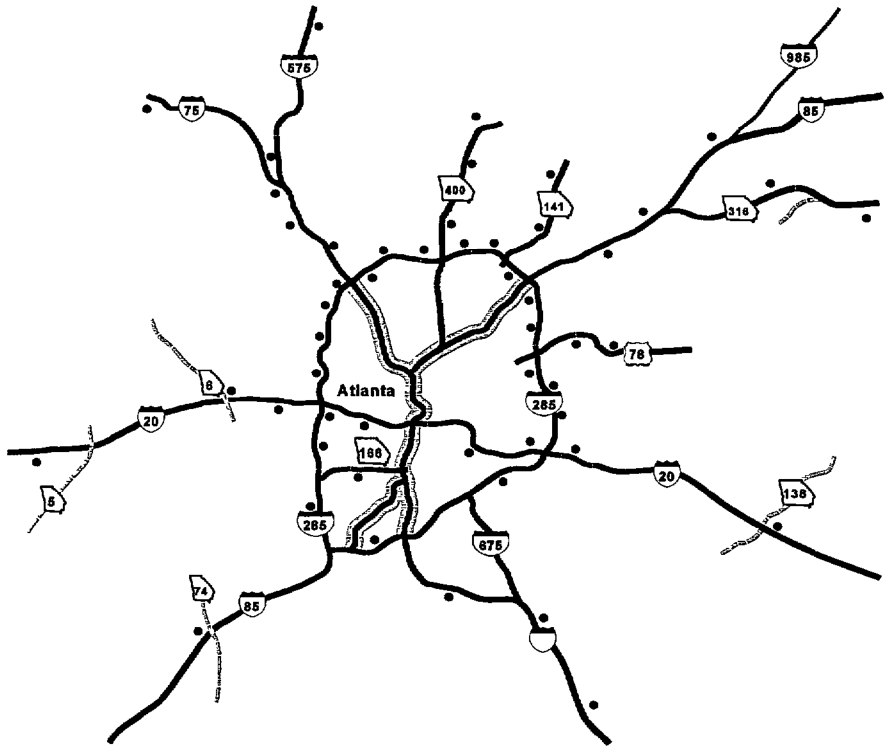


Figure 14. Automated surveillance sites.

operations center would be kept in operation through the end of the Showcase period on September 30, 1996. Appendix E of ***the Surveillance Design Report*** (provided under separate cover as an appendix to this document) identifies in detail the proposed manual surveillance plan.

Alternatives Selected (Manual Surveillance)

Even though the use of fixed-position spotters had been ruled out, it was believed that mobile spotters could play a significant role in the surveillance effort. ACOG had long emphasized the point that spectators would not be able to drive directly to the venues, especially those in the heart of downtown known as the Olympic Ring. Instead, drivers would have to use designated park & ride lots located outside the Perimeter highway and just off the major access routes. From there, spectators would take shuttle buses to the venues or to MARTA rail stations. There was concern that superimposing the spectator traffic onto the daily commuter traffic would create greater-than-normal levels of congestion on the access routes to the park & ride lots and at the Interstate interchanges with those access routes. The Showcase proposed to provide mobile spotters to regularly circulate among assigned lots, their access roads, and key interchanges. These mobile spotters, equipped with cellular telephones, would report roadway conditions (e.g., travel speeds, incidents, congestion, lanes blocked) to Showcase Call Takers at the TMC. They would pay particular attention to the status of key interchange ramps for any back ups that would affect through traffic on the freeway.

Based on the information provided by ACOG, it appeared that eight mobile spotters at any given time would be sufficient to monitor conditions around the park & ride lots. However, the precise location of park & ride lots was not announced by ACOG until just a matter of weeks before the Olympics.

Table 5. Automated Surveillance Sites

SITE NO.	LOCATION	RADARS	CAMERA
1	I-75 at Lyle Dr (north of Delk Rd)	■	■
2	I-285 & Memorial Dr (GA 10)	■	■
3	I-75 & Gresham Rd	■	■
4	I-20 & Martin Luther King, Jr. Dr	■	■
5	I-20 & Columbia Dr	■	■
6	I-285 & East Ponce de Leon	■	■
7	I-285 & Linkwood Rd	■	■
8	I-20 & Flat Shoals Rd	■	■
9	I-20 & Wesley Chapel Rd	■	■
10	I-20 & Thorton Rd (GA6)	■	■
11	I-85 & Old Norcross Rd	■	■
12	I-20 & GA 138 (near Conyers)	■	■
13	I-75 & Bells Ferry Rd	■	■
14	GA 400 & Mt. Vernon Rd	■	■
15	I-285 & S. Cobb Dr	■	
16	I-285 & Riverside Dr	■	■
17	I-285 & Ashford Dunwoody Rd	■	■
18	I-285 & Chamblee Tucker Rd	■	■
19	I-285 & Bouldercrest Rd	■	
20	I-285 & Camp Creek Pkwy	■	
21	Lakewood Fwy (GA 166) & Stanton St	■	
22	I-575 & Univeter Rd (near Canton)	■	
23	GA 400 & Maxwell Rd	■	
24	Stone Mountain Fwy & Silver Hill Rd	■	
25	I-285 & Riverdale Rd (GA 139)	■	
26	I-85 & GA 74	■	
27	I-75 & Jonesboro Rd (GA 54)	■	
28	I-85 & GA 317	■	
29	I-75 & Walt Stevens Rd	■	
30	Peachtree Ind Blvd & Winters Chapel Rd	■	
31	I-575 & Barrett Pkwy	■	■
32	I-285 & Bankhead Hwy (US 278, GA 8)	■	
33	I-75 & Milepost 333 (near Dalton)	■	
34	I-20 & GA 113	■	
35	I-75 & GA 16	■	
36	GA 316 & Patrick Mill Rd (west of GA 81)	■	

Table 5. Automated Surveillance Sites (Continued)

SITE NO.	LOCATION	RADARS	CAMERA
37	GA 316 & US 78	■	
38	Peachtree Ind Blvd & Jimmy Carter Blvd	■	
39	Holcomb Bridge Rd & GA 400	■	■
40	I-85 & Beaver Ruin Rd	■	■
41	I-285 & N. Peachtree Rd	■	■
42	I-285 & Buford Hwy (US 23)	■	■
43	I-285 & Covington Hwy (US 278)	■	
44	I-285 & Lavista Rd (GA 236)	■	
45	I-285 & Powers Ferry Rd	■	■
46	I-285 * Roswell Rd (US 19)	■	■
47	I-285 & Paces Ferry Rd	■	
48	Stone Mountain Fwy & Mountain Ind Blvd	■	
49	I-285 & Cobb Pkwy (US 41)	■	■
50	I-285 & Cascade Rd	■	
51	I-20 & Fulton Industrial Blvd	■	■

In addition to mobile spotters, three people were assigned to the Showcase call-takers room within the TMC to work in rotating shifts. Their days and hours of work were arranged so that one person would be on duty at any time when Metro Networks was fully deployed orwhen Showcase spotters were in service. These employees were to be responsible for monitoring the operation of the automated surveillance equipment, repositioning spotters as conditions warranted, and coordinating Metro Networks' activities with their Operations Manager. They were responsible for obtaining park & ride lot status information from ACOG's transportation command center, either by telephone or in photocopy format, and relaying that information to Showcase call takers.

IMPLEMENTATION

The following subsections highlight the efforts involved in putting into place the various surveillance system components, including automated surveillance and manual surveillance.

Automated Surveillance

The automated surveillance implementation required site engineering and utility coordination, detailed equipment design, coordination with the fixed-end server, construction specifications, installation and inspection, integration and testing, and operation.

Site Engineering and Utility Coordination

The steps to implement the automated surveillance equipment began with preliminary site engineering. An initial site survey was conducted in order to determine if a candidate site was suitable. Nearby telephone and power service were essential, and, for video sites, a clear view of the roadway in both directions was necessary. The preliminary review of sites was necessary before the next step, utility service coordination. Once a potential site was selected by the Showcase and GDOT, the utility companies were called in to advise if both power service and telephone communications could be provided. If a preliminary site was found to be too expensive-requiring significant effort to provide service-or if a site could not be serviced at all, the site was adjusted within the same general area to a point where service was available. When power service and telephone communications were found to be obtainable without difficulty, site sketches and documentation were prepared to properly install the traffic surveillance equipment.

Detailed Equipment Design

While site engineering work was under way, Showcase engineers were busy preparing detailed designs of the surveillance sites. The equipment to be used had been selected tentatively prior to completion of the design report. The detailed work focused on items such as determining what voltage levels would be needed to operate each device and ensuring that communication protocols were compatible. The single-most time-consuming task was designing an equipment cabinet wiring scheme to make the devices function as needed.

Prototypes of each equipment item were either purchased or borrowed and a test site was built in an electronics laboratory. For the most part, the equipment functioned as expected, allowing engineers to finalize the cabinet wiring diagrams. Following this, cabinet specifications were prepared and advertised for quotation from several manufacturers.

Coordination with the Fixed-End Server

Compatibility with the fixed-end server (FES) was essential in order for both the radar and video components of the automated surveillance sites to function correctly. The video system was purchased primarily as a packaged system. The field transmitters were designed by the manufacturer to work with the central receivers over dial-up telephone lines. The only work required was the development of a software-driven user interface to select, dial, and control the video cameras. Complete documentation was made available to Showcase team member TRW for this purpose, and the manufacturer loaned TRW a demonstration unit for several weeks while they developed and tested their user interface.

Development of the interface between the radars and the FES presented much more of a challenge to the Showcase team. Experience with similar systems was valuable for knowing what information needed to be passed back and forth during a communication session between the remote processing unit (RPU) and the FES. Data formats and query/response operations were jointly developed by the Showcase team. Tests were run and minor adjustments were made prior to finalizing the firmware within the RPUs.

Construction Specifications

Detailed construction specifications were developed in order to secure competitive bids from qualified contractors to install surveillance equipment at each site. Each site was slightly different; therefore, it was necessary that measurable pay items be established both as a means of describing the work to be done and to pay the contractor for work completed. The specification included provisions to ensure that all work was in accordance with GDOT specifications as well as national and local electrical codes. Work zone Safety in accordance with GDOT standards also was required.

Installation and Inspection

The installation procedure began with the wood poles. All sites required setting at least one wood pole except for one where a steel pole was attached to an existing bridge fixture. All poles were set and inspected before equipment installations could begin. After all poles were set and inspected for proper location and size, radars, cameras, and cabinets could be attached to the poles. At every site during the installation procedure, at least one Showcase representative was present at all times to ensure quality work and to see that radar detectors were aimed properly.

Integration and Testing

When all equipment had been installed at a particular site, cabinet wiring was completed, power and telephone service were hooked up, and the equipment was tested for proper operation. If all the equipment performed as expected, the site was deemed functional and the site's telephone number was turned over to the FES engineering team to enter into the server's database.

Figure 15 shows a typical surveillance site with both radars and video camera.

Operation

The radar detectors are mounted in pairs, each radar measuring speeds for different directions of travel. At approximately one-second intervals, radars report the measured speed of the vehicle returning the strongest signal within its detection zone at that instant. These speed values are transmitted to the RPU as serial data and are stored for processing.

When the RPUs are initially powered up, they immediately initiate a call to an 800 number stored in its non-volatile memory. This call, which contains the radar site's hardwired address, is redirected to the FES. Knowing the location address, the FES downloads the configuration database for the site as well as a new telephone number for all subsequent calls. At programmable intervals (set at five minutes for the Showcase), the RPU averages the speed values stored for each radar and saves the information for its next communication session with the FEB.

The RPUs can be configured to automatically report in at designated intervals or to wait until polled by the FES. For the Showcase project, the RPUs were set to be polled. In either case, however, the RPUs are programmed to report in immediately if the most recent average speed falls within a speed bin that is different from that of the previous averaging period. The RPUs can be configured with up to ten speed bins, and the bin ranges can be overlapped by the user to minimize frequent bin changes.

Unlike the radar detectors, communication with the CCTV cameras was manually initiated. When alerted to a nearby incident, an operator would select one of three video receiver units using the software-driven interface. Next, a specific camera site was selected. The software interface would retrieve the stored telephone number, initiate the call, and route the received video image to the designated display monitor. Pan-tilt-zoom controls were available through the same user interface. Communication with the cameras continued until terminated by an operator.

Manual Surveillance

Manual surveillance included Metro Networks, mobile spotters, and surveillance supervisors at the Showcase.

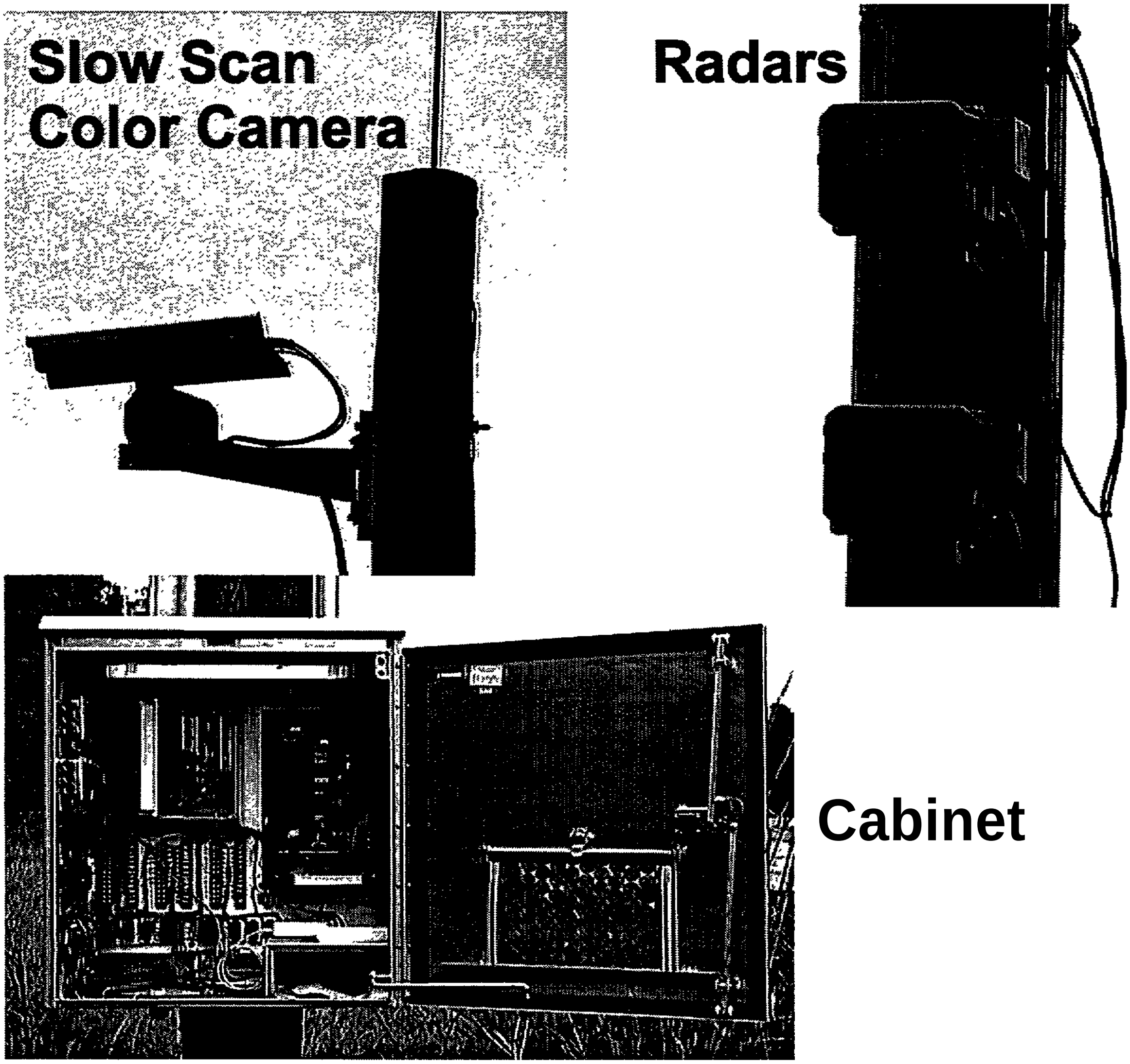


Figure 15. A typical site included radar and video-camera surveillance.

Metro Networks

Representatives from Metro Networks characterized their work as primarily a news reporting service, and as such, much of the methodology familiar to them was unfamiliar to FHWA and the Showcase team. Preparing a scope of work to clearly and measurably define what Metro Networks would do was an arduous task. However, after months of negotiation with both Metro Networks and FHWA, a scope and subcontract were in place.

An initial responsibility for Metro Networks was preparing an Operations Plan to provide further details of the resources they would employ, as well as how, when, and where those resources would be deployed. In large measure, however, the Operations Plan resulted in a restatement of the Surveillance Design Report and of the scope of work. However, the Showcase team felt the report was necessary to ensure that the supplier understood the work to be performed.

A significant feature of Metro Networks' responsibility was establishing a computer terminal in the TMC linked by a modem to their operations center. This terminal was to be the primary source of information flow from Metro Networks to the Showcase Call-Takers' room at the TMC. The Surveillance Design Report envisioned this terminal as an extension of the existing system used by Metro Networks within their reporting studio to distribute information to their various traffic announcers. However, given the unique information requirements of the Showcase project, a separate system was established.

Throughout the project, there was concern about how the Showcase systems would function if the ATMS either was not completed in time or experienced significant down time. Under either of these two scenarios, the Showcase systems were to continue in operation, even if in a downgraded mode. Because the ATMS detectors and cameras were concentrated within the Perimeter, this was the area that would need supplemental surveillance in the event of an ATMS malfunction. Metro Networks was identified as the most appropriate source of supplemental information within the Perimeter. In fact, this was their primary focus area for day-to-day reporting of traffic incidents and congestion in the metro area. A separate subcontract with Metro Networks was initiated that provided for emergency back-up surveillance on I-75 and I-85 within the Perimeter on an hourly basis as needed.

As the June 1,1996 start date for the Showcase approached, it became apparent that the ATMS detectors would not be operational. The team decided to activate the emergency back-up plan for eight hours per day (6 am to 10 am and 3 pm to 7 pm) Monday through Friday. As the Olympics approached, these days and times were expanded first to 13 hours per day (6 am to 7 pm), then to 16 hours per day (6 am to 10 pm), and finally to 18 1/2 hours per day (5:30 am to midnight) seven days per week during the days of Olympic competition.

Emergency back-up services remained in operation throughout the Showcase period. Following the Olympics, the hours were scaled back to 13 hours per day through the Paralympics, then reduced further to 8 hours per day, 5 days per week through the end of September.

The critical items of information needed were travel speed and location. Without this information, the end-user devices would have had no way of advising motorists of traffic conditions within the Perimeter, except from the few Showcase radars within the Perimeter on I-20 and on Lakewood Freeway. In the first few days of Showcase operation, it became apparent that Metro Networks reporters were referencing locations by their common names (e.g., Brookwood, the south split, the Grady curve). While they, and most Atlanta drivers, knew where these areas were, the Showcase database did not contain these references. Metro Networks was given a copy of the database and asked to format their reports using actual roadway names when identifying the location of incidents and congestion.

A secondary level of emergency back-up surveillance was devised a few days into the Showcase period. The surveillance supervisors who had the capability to select and view ATMS cameras were instructed to use these cameras to routinely scan the roadways for signs of incidents and congestion.

Spotters

Mobile spotter routes were constantly changing depending on ACOG's decision to use certain park & ride lots. Routes were not definite until one week before Showcase spotters were to begin work, and ACOG's park & ride lot list changed from week to week. As the Showcase period approached, it was determined that nine spotters should be hired rather than the originally proposed number of eight. Routes were defined approximately one week before spotter training began. Reference material was distributed to spotters at the training session so they could become familiar with their routes before actual "spotting" began.

The park & ride lot list from ACOG consisted of 46 lots in and around metro Atlanta, while others were located far from downtown Atlanta. Many of the lots contained a few hundred spaces. Only lots that had 500 available spaces or greater and were located within a reasonable distance from both downtown Atlanta and major highways were considered for surveillance. Of those remaining lots, 9 separate routes were defined so spotters could travel from at least one end of the route to the other end in 15 minutes. The reason for this was that during the peak hours, spotters were to call about their route conditions every 15 minutes.

Training the spotters was necessary in order for them to know how to report observed conditions, how often to report conditions, what conditions to be aware of, and other details such as telephone use and time sheet/travel expense charging. Spotters were told during training that routes might change depending on park & ride lot priorities and/or changes. In fact, one park & ride lot monitored by spotters was closed due to poor attendance, and that particular route had to be changed.

Reporting speeds along each route was almost impossible if variations along that route existed. Also, certain routes involved driving through a series of traffic lights. Speeds in these situations were not that important because traffic lights primarily dictated how traffic moved if no accidents were present. Therefore, the spotters were instructed that they did not need to report travel speeds to the TIS operators, but they needed to be aware of incidents and accidents that would affect travel speeds.

When the demonstration began, the Showcase team learned that park & ride lot conditions, such as the number of available spaces, were not being reported by ACOG officials as initially expected. Consequently, all spotters were contacted and directed to observe park & ride lot conditions from the road. Specific conditions within the lots because those entering the lots were required to pay a fee. Also, driving through the lots would have taken valuable time away from driving the routes. Spotters were directed to observe as closely as possible the approximate number of available spaces from their route.

All park & ride lots were closed after the Olympic period. The Paralympic Committee did not implement spectator parking or a transportation system similar to that used for the Olympics. The team had anticipated that lots would remain open for both the Olympic and the Paralympic periods, and as there was no need for spotters to drive around park & ride lots after the Olympics all routes were modified to include only interstate routes or major arterials not already covered by ATMS.

Surveillance Supervisor

The team's original plan called for the surveillance supervisors to monitor mobile spotters, reposition them as conditions warranted, coordinate manual surveillance operations with Metro Networks, and report equipment malfunctions to Showcase maintenance personnel. As the Showcase period approached and operations were under way, the surveillance supervisors were assigned additional duties.

The most challenging responsibility was validation of information received from Metro Networks. The supervisors were asked to use any resources available (e.g., ATMS cameras, radar data, slow-scan cameras) to see that the data received from Metro Networks was correct before it was entered into the Showcase server. Supervisors also advised the Call Takers when data discrepancies occurred, and used the ATMS cameras to routinely scan I-75 and I-85 inside the Perimeter for incidents and congestion in the absence of automated data from the ATMS detectors.

Lastly, the surveillance supervisors were asked to monitor the cable TV system for any signs of malfunction. At many times during the day and on weekends, the cable TV system operated unattended; however, it did not operate free of problems. To keep a closer check on the system than was possible by the Showcase Operations Manager, one of the surveillance monitors adjacent to the surveillance supervisor was configured to receive the video output from the cable system. Malfunctions observed by the supervisor or any of the Call Takers could be quickly reported to the Operations Manager.

LESSONS LEARNED

Several lessons emerged regarding automated and manual surveillance during the TIS project:

- **Site selection requires patience and flexibility. The** original list of sites changed after field testing as power and telephone availability were evaluated.

- **Coordinating the siting effort can be difficult and time consuming.** Telephone and power company representatives need to be involved; however, it is extremely critical to ensure consistent communication within the companies. Power companies can have multiple districts within a region, as is the case in the Atlanta metropolitan region, with different representatives for each. Inconsistencies among the decisions of the engineers resulted in delays in the Showcase team's work, primarily due to meeting special permitting requirements.

- **Permits and applications take** time. For example, 10 surveillance sites fell within Electrical Membership Corporation (EMC) territories or city electrical utility companies. In most cases, application for service as well as deposits had to be made in person, which was unexpected. Also, Jackson EMC was asked to trench in the power service to two surveillance poles because their charges for doing so were lower than those quoted by the contractor. This too was more trouble than expected in that permission forms identified the applicant as the "Owner" of the property, which was not the case. Revisions to the standard forms delayed the underground service work for about two weeks until differences could be settled.

- **Installation of surveillance equipment requiring utilities (electric and phone) along an interstate can prove to be difficult because interstates do not usually have addresses. In** the Atlanta metropolitan area, BellSouth could not provide service without an address, and all of the surveillance sites were located on interstates or access-controlled state roads. BellSouth's system is set up so that any location desiring telephone service must have an address in order for it to be entered into their computers. Therefore, a representative from BellSouth decided to use an address closest to the service point. This originally seemed feasible; however, the addresses confused some installers. Many telephone interface boxes were installed at the address given on their work orders, which in most cases was some distance from the desired location. In those instances, Showcase technicians met representatives from BellSouth to show them where to move the telephone line. The installations could have proceeded more smoothly if the installers had been given a sketch of the site. Instead, all they received was a computer printout of the usually incorrect address.

- **The equipment procurement process took decidedly longer than had been anticipated. Certain equipment, such as modems and wooden poles, were delivered on schedule.** However, the radars and associated equipment took much longer than expected and actually caused significant delays in project construction completion. Equipment cabinets were fabricated to meet exacting specifications; therefore, it was evident that the cabinets would take some reasonable time for manufacturing and delivery. However, the radars were purchased without any modifications and should have been delivered without excessive delay, which proved not to be the case.

- **It is imperative to test and calibrate the radars as they are being installed.** The radars were not wired and tested until a few days after all equipment was mounted on the pole at the first construction site. The radars were simply installed by aiming them at what was believed to be the appropriate point along the roadway, which was not very efficient because it was only an estimate of where the best speed readings would be detected.

- **Radars can be temperamental.** The source of the radar maintenance problems was never accurately diagnosed, but may be attributed to several factors. The late spring and early summer weather in Atlanta, during which most of the radars were installed, produced several severe thunderstorms. Although the radars were protected with surge arrestors, transients and surges produced by these storms could have damaged the radars. Additionally, the extremely high temperatures coupled with an input voltage near the top end of the manufacturer's recommended range also could have led to some of the problems. Lastly, most of the failures occurred within the first few days and weeks of operation. Failure within one or more of the electronic components also could have caused the problems. As the operational period continued, lack of thunderstorms and cooler temperatures resulted in a significant decline in the number of radar problems.

- **Calibrating the radars can be formidable.** Ideally, a radar detects speed most accurately by being placed directly over the vehicle it is attempting to detect. However, ease of installation dictated that the radars be mounted adjacent to the road on a pole. Securing permits from GDOT to attach the radars to bridges or overhead sign structures would have taken several months, and time constraints did not allow for such delays. Mounting the radars next to the road and aiming them toward the traffic to be detected introduced an angle into the system for which a correction factor was needed.

- **Good manual surveillance requires a team effort.** Information reported by Metro Networks by way of the Studio Trak terminal proved to be valuable, as the ATMS detectors were not operable. The reporting format that had been determined in advance included all the essential pieces of information needed by the Showcase systems. In reality, however, it was difficult and time consuming for the Surveillance Supervisors and Call Takers to extract the essential bits of information from the written messages. It also was difficult for the Call Takers to distinguish an update of a previous report from a new report that might be in the same vicinity. Each of these problems were gradually worked out. Reports were made more uniform and updates were clearly identified. Significant strides were taken to improve communication when Call Takers and Metro Networks' reporters took the time to visit each other's work sites for a day to get a first-hand understanding of where the problems were and to reach a solution. It became evident after only a day or two that the Studio Trak terminal by itself was not the best method of transmitting information. A printer was added to the terminal so that incident reports could also be printed and distributed to the Call Takers for entry into the Showcase server. The printouts also provided a permanent record of the reports received.

- **Using mobile spotters can present challenges to a project team.** After deciding to hire the spotters directly, the Showcase team placed advertisements about the temporary positions in the local newspaper and also at Clark Atlanta University. The newspaper ad was originally placed under the 'Transportation" heading. After a very poor response, the ad was placed again, but under the "Drivers" heading and adequate responses were received. Once the spotters were hired, maintaining constant supervision was impossible, because the spotters worked from 6 am until 10 pm, 7 days a week, so each spotter was met on the job and in the field twice a week. The cellular telephones given to the spotters presented some problems as well, such as making personal calls, having the telephones stolen, and having telephone numbers cloned and used illegally elsewhere in the country.

Olympic Coordination and Operations Planning

Olympic Coordination and Operations Planning were grouped together more as a matter of evolution as the TIS progressed rather than initial planning. BRW was originally selected as a core team member because of their past work with Olympic and Special Olympic events. This experience was to be the basis for insight and interface support with the various Olympic Committees in Atlanta during the Summer of 1996. However, as the project progressed, it became clear that the coordination effort with the Olympic Committees would not require the level of effort initially anticipated. It also became clear that during the Showcase planning, no organization within the TIS project team had been given direct responsibility for the TIS operations from June 1 to September 30,1996. As a result, BRW's scope of work was changed, and they became responsible for the TIS operational period. Battelle assumed the role of interfacing with the Olympic Committees as part of their project management role.

Olympic Coordination

One of the reasons for having the TIS in Atlanta during the Summer of 1996 was that the Centennial Olympic Games also were held in Atlanta from July 19 to August 4. The anticipated 2.5 to 3 million visitors expected to arrive in the Atlanta area for this event were certain to have a significant impact on the traffic flow. Therefore, it was appropriate to try to coordinate the travel and traffic information in the TIS with the Atlanta Committee for the Olympic Games (ACOG).

OBJECTIVE

The transportation plan for the Olympics funneled spectators into Olympic Games park & ride lots, located mostly outside of the Perimeter(I-285) and onto the mass transit system provided by the Metropolitan Atlanta Rapid Transit Authority (MARTA) (see Figure 16). From these park & ride lots, spectators would then board the Olympic Transportation System (including MARTA) and be shuttled to the events. The TIS anticipated providing users with information about the location, status (full or empty), and size (number parking spots available) of the park & ride lots and encouraging the use of MARTA (Figure 17).

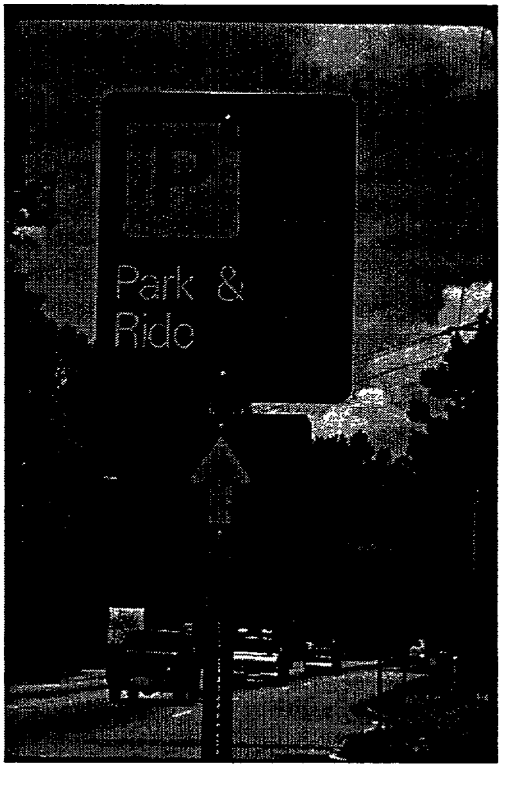


Figure 16. Park & ride lots were an essential part of the Olympics' transportation plan.

APPROACH

Alternatives Considered

In the Spring of 1995, contacts were initiated between the TIS and ACOG. Initial meetings were held to introduce ACOG to the TIS and to explain the goals of the TIS for the Olympic period during the Summer of

Figure 17. The objective of the park & ride lots was to encourage use of public transportation.

1996. The TIS team did not at any time attempt to associate the program with the Olympics, either through sponsorship or casual references.

The TIS made it clear to ACOG that our desire was to acquire information regarding their park & ride lots as well as any information available regarding the Olympic Transportation System. An offer was made to ACOG to assist in the collection of this information in any way possible, which included the following:

- Placing personnel hired by the TIS in Olympic park & ride lots to report status information to ACOG, which would then be forwarded to TIS personnel at the Traffic Management Center

- Instrumenting some or all of the park & ride lots with an automatic counter that could report the desired status information

- Using ACOG employees/volunteers to report the status of park & ride lots and have this information forwarded to TIS personnel at the Traffic Management Center

- Using bus drivers to report the status of park & ride lots as they service each lot, and have this information forwarded to TIS personnel at the Traffic Management Center.

Alternatives Selected

Based on a series of meetings, ACOG made it clear that it was not acceptable to put TIS personnel in the Olympic park & ride lots. Their major concern dealt with their sponsor protection requirements and the fear that non-Olympic sponsor equipment could be used in the collection of this information.

However, ACOG too had a need for accurate status information of their park & ride lots. In order to manage the transportation system, they needed to know accurate counts of available parking spaces and how quickly the parking lots were filling up.

Early in 1996, ACOG agreed to collect status information from their park & ride lots using ACOG employees/volunteers. It was agreed that this information would be made available to GDOT on an hourly basis at the TMC, and they could then forward that information as needed.

IMPLEMENTATION

A procedure was established within the TIS to input park & ride lot status data into the FES where the technology devices could access it. When GDOT received a report from ACOG, they would copy the information and pass it to a TIS Call Taker located in Room 109 at the TMC. The designated Call Taker would then input the data directly into the FES database. The information to be collected included lot location, number of parking spaces available at each location, and a real-time update regarding the capacity of the parking lot. Similar to the speed reporting, the lot status was reported in “bins” indicating that a particular lot was 100 percent full, 80 percent full, or 60 percent full.

LESSONS LEARNED

During the development and operation of the TIS, several lessons were learned regarding integration and cooperation with ACOG:

- **The reporting of status information on Olympic Games park & ride lots did not work.** While the plans and procedures were established for ACOG to report this information to GDOT, when the Olympics began, the reporting was inconsistent, not on a timely basis, and was not of use for the TIS. After the second day of poor data, it was decided (between the TIS and FHWA) to discontinue reporting of real-time status information on the Olympic Games park & ride lots.

- **Establishing a good, cooperative working relationship with ACOG would have facilitated the Showcase** efforts. ACOG, however, was facing a nearly impossible task (putting on the largest Olympic Games in history), and while they needed some of the information and services that could be provided by the TIS, they had too many competing needs for their time and attention to dedicate any meaningful effort to working with the TIS. In addition, with the huge sums of money required to become an “Official Olympic Sponsor” (up to $40 million), great concern was given to non-sponsors and how any cooperation and/or working relationships might appear to give them an association with the Olympics without paying.

- **The location of the park & ride lots was not decided and verified soon enough. ACOG** had initial agreements with 60 to 100 sites to serve as park & ride lot locations but was very slow in getting a signed contract with each of these sites. As a result, as late as the second day of the Olympics, the locations of some of the park & ride lots had not been confirmed and it was not certain that all these lots would even exist. This was a significant problem for the TIS. In order for the ISP devices to properly report the status and location, they needed to know exactly where these lots were located. The TIS included route planning capabilities on most devices, but for these to work required each location to have a latitude and longitude reference location. Until the final locations were established by ACOG, this information could not be coded into the TIS devices and the real-time (even if available at the FES) information could not be provided to the TIS users. For example, due to logistical constraints of providing hard disks for each of the 100 vehicles to be equipped with the in-vehicle navigation device, it was necessary to cut off any modifications to the map database by April 1, 1996, for the in-vehicle map database. As a result, the list with locations of park & ride lots in the in-vehicle map database was approximately 60 percent accurate at the time of the Olympics. The other 40 percent of the lots had either changed locations or been replaced.

Operations Planning

OBJECTIVE

The objective of the operations planning for the Atlanta Traveler Information Showcase was to establish an organizational structure and provide trained individuals to operate the Showcase for the period June 1 to September 30,1996. Operations planning included identifying the staff and financial resources needed to support the Showcase from June 1 to September 30, 1996, establishing milestones for meeting the June 1 start date, and establishing policies and procedures for timely and accurate collection, processing, and distribution of information for travelers.

BRW, Inc. was responsible for planning, organizing, and directing the personnel, tasks, and functions for operating the Showcase project. The approach to operations was threefold: maintain consistent, accurate, and timely collection of real-time traffic incidents and speed data; maintain timely, consistent, and accurate output of the data to the five devices; and maintain the devices and the fixed-end server (FES) in peak operating order.

APPROACH

An Operations Plan was developed in late 1995 and distributed to all stakeholders for review and comment. The plan included a schedule for timely implementation of operations on June 1,1996, roles and responsibilities of individual staff, training and recruitment, and procedures for monitoring Showcase operations. For specific details on the Operations Plan for the Showcase, please refer to the ***Management and Staffing Plan for the Traveler Information Showcase Operations Center*** (provided as an appendix to this document).

A number of positions were established to staff the operations center of the Traveler Information Showcase. ***The Showcase Operations Manager*** position directed the daily activities at the Showcase operations center. An Operations Manager was on site at the operations center during all operating hours. In addition, an Operations Manager was on call during all hours that the operations center was not staffed. The Showcase Operations Manager on duty could be reached by calling a designated telephone number. When the Showcase operations center was not staffed, a recorded message directed the caller to the Showcase Operations Manager on call.

The Surveillance Supervisor position was responsible for monitoring the performance of mobile spotters, coordinating spotter operations with Metro Networks, and reporting surveillance equipment malfunctions. In addition, the Surveillance Supervisor was responsible for working with the Call Takers to review data and resolve data inconsistencies. The Surveillance Supervisor reported to the Showcase Operations Manager and was on site during all hours of operation.

A ***Cable TV System Operator*** was on site at the operations center during the peak travel periods to provide live voice narration to the cable television program produced by the Showcase.

A ***Systems Operator*** was on site from 7:00 am to 5:00 pm, Monday to Friday to maintain the Showcase processing system and fix software-related problems. The systems operator was available by telephone and pager at all other hours.

Call Takers at the Showcase operations center received traffic, accident, and travel information, then entered the data to be processed by the Georgia Department of Transportation's (GDOT) Advanced Traffic Management System (ATMS). Three Call Takers were on duty 16 hours each day, seven days per week, throughout the Showcase period and during extended hours over the Olympic period (see Figure 18).

Initially, the operations plan called for one full-time position to be assigned to MARTA to act as a liaison between the Showcase project and MARTA operations. This position was funded for 16 hours per day, 7 days per week from June 1 to September 30. Beginning in January 1996, a number of discussions took place between MARTA and Showcase personnel on the role of the MARTA liaison. At the end of April, it was mutually agreed that MARTA did not have a need for the liaison position and this position was not filled.

Figure 19 shows the organization of the Showcase operations center. Additional detail is available in ***the Management and Staffing Plan for the Traveler Information Showcase Operations Center.***

A number of the staff for the operations were hired exclusively to work on the Showcase project. BRW recruited and hired college students to serve as Call Takers, JHK and Associates hired individuals with automobiles to serve as Surveillance Spotters, and JHK hired retired individuals to serve as Surveillance Supervisors. Battelle retained the services of a commercial traffic reporting company to supply traffic reports and to provide individuals to serve as the cable TV system operators. Other operations staff were employees who participated in the development of the Showcase system. Up to four weeks of training and orientation for Call Takers was set aside in May 1996. Actual training required much less time than anticipated, which is discussed in greater detail later in "Implementation".

Two written manuals were prepared for use by the operations ***staff. The Call-Takers Training Manual,*** provided as an appendix to this document, was a training manual for the Call Takers that outlined Showcase operations and provided detailed instruction on using the Showcase and GDOT data entry systems. The ***Call-Takers Training Manual*** was revised in October 1996 to reflect changes made during the four-month operations period. A second document, ***the Reference Manual for Operations Managers,"*** was prepared for the operations managers and described the overall procedures for Showcase and GDOT operations including names and telephone numbers of key personnel.

The approach to hours of operation was to staff the operations center from 6:00 am to 10:00 pm, 7 days per week, including holidays. During a four-week period from July 14 through August 10, the operations center was scheduled to be staffed from 5:30 am to 12:00 midnight. When the operations center was not staffed, an Operations Manager and other support staff were on call. Based on the hours of operation, individual work schedules were established and provided to all operations staff.

10 Although it is available, the ***Reference Manual for Operations Managers*** was not prepared for use as a public document. It contains personal contact information and information taken from the GDOT operations manual, and it is not appropriate for general use.

A number of procedures were established for the Showcase operations:

- Steps for confirming" an incident submitted by the commercial traffic reporting service
- Telephone answering policies for both GDOT and Showcase calls
- Consistency in terms and phrases used by GDOT and Showcase personnel
- Schedules and checklists for monitoring each device
- A daily journal to record activities and serve as a resource for the operations managers
- Detailed actions to be taken in response to operational problems
- Daily meetings of operations staff
- Daily communications with GDOT staff
- An established succession of individuals to call for specific problems
- Emergency back-up plans and "manual" operation.

At the initiation of the operations on June 1, all operations staff were prepared to work with the system that was delivered and to modify their expectations to the actual capabilities of the system that was in place on June 1. This initial start-up period prior to the Olympics provided hands-on experience and interaction with technical staff that led to a solid understanding of the data entry, processing, and distribution systems.

IMPLEMENTATION

Before establishing operating procedures, the Showcase project managers met with GDOT managers throughout 1995 to discuss the overall coordination and interaction between the Showcase project and GDOT. In early February 1996, Showcase operations staff held initial meetings with the manager of operations for GDOT. Coordination with GDOT began immediately with discussions on the roles and responsibilities of Call Takers, telephone needs, along with dates and materials for Call-Taker training. Another area of discussion with GDOT operations personnel was that the appropriate GDOT cameras be designated for use in the live surveillance segment of the automated cable television program.

An orientation session to address daily procedures was held on May 30 with Operations Managers and others serving on the Showcase operations team, and the TIS became operational on June 1. Showcase operations continued through September 30,1996, and the TIS was staffed 16 hours a day, seven days a week from 6:00 am to 10:00 pm. During a four-week period from July 14 to August 10, on-site staffmg was expanded to meet the expected needs associated with the Olympic and Paralympic Games. The expanded hours of staffing covered 18% hours per day from 5:30 am to 12:00 midnight. Neither the Paralympics nor the Olympic Games generated sufficient data during the extended hours to warrant staffing the extended hours; therefore, on August 6, staffing levels returned to the 16 hours per day level.

Initially the information collected and reported by the Showcase project came under close scrutiny by GDOT and FHWA officials who sought to verify the accuracy and timeliness of the information. The performance of Call Takers and managers, and the data from the commercial traffic reporting service were all monitored on a daily basis. Within a short period of time, it was recognized that the information generated by the Showcase project was reliable and a level of trust was established with the accuracy of the information being reported.

11 "Confirmed" means that GDOT has verified that a reported incident has really occurred. For example, a call from a GDOT employee or Georgia state trooper or a camera image confirmed an incident.

Operations Managers and other operations personnel met daily during the change of shifts to discuss events that occurred during the shift, including discussing how various problems and issues were resolved, and identifying items that were unresolved. Initially, these daily meetings involved a number of items; however, as the operations progressed, the duration and content of these meetings was reduced.

During the Showcase operations period, interaction with GDOT operations personnel occurred regularly and was primarily between the Showcase Surveillance Supervisors and GDOT's shift supervisors. This daily interaction included sharing information on incidents and speed, acquiring additional information on incidents and changing GDOT's video feed to the Showcase cable television show when necessary. An excellent working relationship developed between GDOT and Showcase personnel that contributed to an exceptional work environment at the operations center.

Call Takers played an important role in the daily operations of the TIS. Recruitment for the Call-Taker positions was handled through Atlanta-area colleges with a special focus on historically black colleges. Thirty-nine resumes were received and 33 interviews were conducted in March and April. Eleven people were offered positions and completed the training and orientation. Eleven people were hired to fill 10 positions, with the extra person hired as a backup. One week after training, one full-time person resigned due to a job offer related to their field of study. The remaining 10 employees remained with the project for the duration of the four-month operational period. Table 6 summarizes the recruitment for the Call-Taker positions. Training for the Call Takers began with the development of a training manual that was prepared with input from GDOT and other members of the Showcase team. The training manual was reviewed and revised several times, then finalized in mid May 1996. Initially, the training schedule called for training to begin in early May and continue for most of the month. After considering the material to be covered and the status of system development, a two-day training session was set for May 21-22, 1996. Call Takers became proficient with the computer system after the first week of operation.

Another essential aspect of the operational activities of the TIS involved the mobile spotters. During the Olympic Games, mobile spotters monitored and reported traffic conditions for access to and from the Olympic park & ride lots. After the Olympics, the mobile spotter routes were changed and expanded to give greater coverage around the I-285 Perimeter and on the main east-west corridor of I-20. This service was well received and provided more accurate information in these areas. The role of mobile spotters evolved to the point that GDOT requested that spotters be dispatched to some incident locations to provide additional information. These requests were made when GDOT did not have resources available, (i.e. incident response units, cameras) to verify information on a reported incident and showcase mobile spotters were in a position to reach the site easily and report on the situation.

Coordinating the confirmation of incidents between GDOT and Showcase was an ongoing process and evolved over time. Originally, Showcase staff did not confirm any incidents; only GDOT personnel performed this task. During the first month of operations, Showcase personnel and Metro Networks consistently demonstrated that the traffic information collected was accurate. Early in July, Showcase Call Takers entered confirmed incidents when Metro Networks clearly reported an incident blocking lanes of traffic or when a surveillance supervisor noted an incident on the cameras. At this time, there was additional emphasis placed on the coordination between the Showcase surveillance supervisor and the GDOT shift supervisor through face-to-face communications.

Table 6. Traveler Information Showcase Summary of Call-Taker Interviews

SCHOOL	NUMBER OF RESUMES RECEIVED	NUMBER OF INTERVIEWS: HELD	NUMBER OF INTERVIEWS: CANCELED OR NO SHOWS	JOB OFFERS: PT POSITION	JOB OFFERS: FT POSITION	JOB OFFERS: TOTAL	ACCEPTED EMPLOYMENT	COMMENTS
Albany State College	7	3-in person 4-phone		0	1	1	1	A number of candidates had no housing.
Clark Atlanta University	9	8	1	1	4	5	5	Most candidates were Computer Science majors.
Emory	3	2	1	0	1	1		
Georgia State University	4	4		0	2	2	3	
Georgia Institute of Technology	5	5		4	0	4	1	Candidates all had Civil Engineering background with Transportation focus.
Morris Brown	1	1		0	0	0		
Rutgers	1	1		0	1	1		
University of Georgia	1		1	0	0	0		
Other Schools	4	2	2	1	0	1	1	
No School Affiliation	4	3	1	0	0	0		
TOTALS	39	33	6	6	9	15	11	

Interviews were held in Atlanta on February 27 and 28; and on March 19 and 20.1996; another was held in Newark New Jersey, on March 13.1996.

Originally, Metro Networks was to report their information only through a monitor located in the Call Takers' room. Soon after operations began, it became clear that it also was necessary to have the information available on paper. Metro Networks installed a printer in the Call Takers' room and the hard copy was circulated among the Call Takers for data entry and made available to GDOT operations staff. In addition, a printer was located in the cable television production room to provide information to the live operators who provided voice-over programming.

Manual speed reports were relied upon more heavily than expected because automated speed reports were not available from the ATMS. Information was gathered from camera surveillance by the Surveillance Supervisor, the commercial traffic reports, and mobile spotters. Call Takers entered speed data by identifying segments on the highways within the I-285 Perimeter and entering the associated speed as verified through the surveillance resources. (Green indicated 51+ mph traffic flow, yellow indicated 31 to 50 mph, and red indicated stop-and-go conditions of 0 to 30 mph.)

During the Olympic Games and the Paralympics, the cable television system operator reported real-time information during the morning and evening peak hours. The cable television system operator used information available from GDOT's ATMS, information generated from the Showcase, and printed reports from Metro Networks. The live voice narration added more interest to the automated program and was well received in the community; therefore, it continued to the end of the project as part of the operations support.

There was a significant amount of time spent keeping the processes operating and providing accurate output of information on the devices. Over time, operations personnel became familiar with the characteristics of the system and enhancements were made to the software that led to quicker responses to system problems.

LESSONS LEARNED

Several lessons emerged from the operations of the TIS:

- **The importance of developing a back-up plan for operations cannot be underestimated.** A significant amount of thought and effort went into developing back-up systems to collect and distribute information in the event any or all of the automated systems failed. Back-up systems were put in place that allowed the Showcase to collect and process information independent of the ATMS. There also was a system in place that allowed the Showcase system to transfer over to a back-up processing system in the event the main system became disabled.

  The back-up plan that was used most during the Showcase project was a system to manually collect speed information. This back-up system consisted of a contract with Metro Networks that provided reports on speed conditions every 15 minutes during peak hours and every 30 minutes during off-peak hours. This back-up system was used for speed information on Interstates 75 and 85 within the Interstate 285 Perimeter. This back-up system was deployed throughout the entire Showcase period and without it, the Showcase project could not have accurately reported speed conditions on the most heavily traveled sections of interstates in the Atlanta area.

- **The data entry and incident verification functions required fewer staff than anticipated.** Contributing factors included the limited number of calls, the fewer-than-anticipated incidents, and lack of information from ACOG on the status of park & ride lots. Another observation of our staffing needs was that data entry and verification tasks were not constant and as a result, Call Takers and Surveillance Supervisors had periods of little or no work to perform. During these periods of “down time,” Surveillance Supervisors would conduct “video patrols;” that is, calling up cameras and searching for incidents or congestion. At other times, the Call Takers assisted with administrative tasks associated with the Showcase project and were given the opportunity to reduce their hours of work. Planning secondary or back-up work assignments for dam entry and verification personnel helped turn “down time” into productive time.

- **A Monday-to-Friday operation would have been sufficient to meet the needs of the Showcase project.** Only when a special event was scheduled for the weekend was it necessary to have one or two data entry/verification personnel present at the operations center. There was rarely sufficient congestion or incidents to warrant data entry on weekends. This was particularly true when incidents entered by GDOT were automatically entered into the Showcase system.

Marketing and Public Relations

Marketing and Public Relations

In recent years efforts to improve surface transportation through advanced technologies have developed into a national intelligent transportation systems (ITS) initiative. People close to the transportation industry are aware of the potential and operational capabilities of ITS. But most people have little knowledge of ITS and how it can improve their travel experiences. The marketing and public relations required for the Showcase needed to educate the public about ITS and communicate the availability and accessibility of the TIS.

OBJECTIVE

The communications objective of the Traveler Information Showcase public relations program was to capture and present the real-world experience of real-time traveler information in the Atlanta area to targeted audiences. Through discussions with FHWA, six target audiences were identified. They included local travelers, travelers into Atlanta for special events, transportation professionals, local/national influencers, national/international public-at-large, and the media. The objective of the public relations program was to develop and implement an effective approach to reaching these audiences and communicating the benefits of traveler information demonstrated by the Showcase.

The measure of success from a public relations perspective was whether the Showcase advanced awareness, understanding, use, and support for real-time traveler information and intelligent transportation systems among the general traveling public, transportation professionals, local/national influencers, and the media. Thus, quantity and quality of coverage by the media and frequency of direct marketing to other audiences serve as indicators of the success of this element of the Showcase.

APPROACH

The overall approach taken was to develop a plan that would be appropriate to the characteristics of each target audience. This meant understanding the type of information that would communicate the message of the Showcase and the means for effectively reaching the audiences. A major consideration was whether the Showcase would be noticed within the barrage of publicity in and about Atlanta leading up to the Olympics.

Resource constraints are always a factor in planning a publicity campaign. The budget did not permit advertising in print or broadcast media; therefore, the plan had to rely on less costly means for reaching the target audiences, especially Atlanta residents and visitors and the national public at large. Coordination of Showcase media relations efforts with that of public agencies and private sector team members was another consideration in planning and implementation. In addition to minimizing any potential conflicts, such coordination would help leverage the public relations investment of each participant for a much greater effect than could be realized individually.

The Atlanta Traveler Information Showcase: Public Relations Program, published on June 1, 1995,[12] laid out the activities and collateral materials to be used for reaching targeted audiences. The schedule in the plan was timed to build awareness and interest in the Showcase so it would peak as the Show-

[12] Walcoff & Associates prepared the plan, which is provided as an appendix to this document.

case went into operation on June 1,1996. As the plan began to be implemented, some midcourse adjustments were made to take advantage of opportunities and to react to unforeseen circumstances. For example, some publications were delayed to optimize their exposure. Another change in plans involved adding an on-site media relations staff member to the Showcase office in Atlanta to deal with the media during the four months of operation. The Showcase also received a request from FHWA to participate in the ribbon-cutting ceremony for the opening of GDOT's Transportation Management Center in April 1996. Preparations for this ceremony involved significant preparation of graphic material, interviews with the media covering the ceremony, demonstrations of Showcase technologies to attendees, and other forms of support that were not part of the original public relations plan.

Alternatives Considered

The challenge of the public relations program was to gain the attention of each targeted audience. Showcase information had to compete with all the other information that regularly confronts the public, transportation professionals, key decision makers and influences, and journalists. The difficulty of the task was heightened because the Showcase ran concurrently with one of the great news events of any year, the Olympic Games.

Among the public and media outreach efforts considered for the Showcase were the following:

- Placing articles in the transportation trade press
- Hosting events designed to bring the media to Atlanta so they could experience the Showcase first hand
- Retaining a periodical clipping service to monitor coverage of the Showcase in newspapers, magazines, and newsletters
- Developing an exhibit booth for trade shows and conferences, and for display in public places
- Developing an exhibit centered on ITS for display at Sci-Trek, Atlanta's science museum
- Developing a Showcase database of journalists and transportation professionals to receive a regular series of press releases, newsletters, fact sheets, brochures, and other collateral materials detailing the progress of the project
- Pitching the story to the national electronic media
- Attracting media attention through celebrity user promotions
- Issuing press releases
- Creating a Traveler Information Showcase Source Book for the media
- Shooting broadcast-quality video footage during the test period in April 1996, which would provide a visual for 'B-Roll #1' to be distributed to broadcast media
- Sponsoring radio public service announcements

- Hosting supplemental media events such as a public relations planning meeting and two editorial board meetings

- Shooting additional broadcast footage (during the Summer of 1996); producing 'B-Roll #2' for distribution to TV and cable audiences.

The overriding consideration of funding, both the total amount and what public funds could be used for, was an important issue. For example, an advertising campaign to inform the public in Atlanta or other parts of the country would not have been practical because print ads could easily exhaust the entire public relations budget. In another case, paying travel costs for journalists to visit Atlanta, something done in the private sector for the trade press, was ruled out as it was not an acceptable use of public funding.

Alternatives Selected

A range of activities and materials were selected for the marketing and public relations program that would provide regular communication to the targeted audiences and fit within the resource constraints of the program:

- Developing a series of press releases

- Preparing brochures and fact sheets describing the Showcase and its individual components

- Distributing newsletters to a comprehensive mailing list

- Preparing a media resource guide for journalists providing contacts for Showcase team members

- Holding a one-day media event to give hands-on experience to journalists

- Developing slide presentations for use by FHWA and Showcase team members

- Distributing video B-roll to television journalists

- Giving flyers to the public and employers to raise awareness about the Showcase

- Preparing presentation folders, a logo, and other brand identifiers (stationery, envelopes).

IMPLEMENTATION

Implementing the marketing and public relations program involved producing and distributing print material and managing an ongoing media relations program. The bibliography provided at the end of this document contains a comprehensive listing of media coverage of the Showcase. In addition, the Showcase marketing and public relations program was coordinated with the public and private sector team members.

Coordination with Public and Private Sector Members

Logo Development and Use

The Showcase participated in developing a logo with public sector entities (FHWA, GDOT, and MARTA) that would be used to symbolize traveler information in Atlanta. The participating agencies agreed to use this logo to communicate consistently the availability of traveler information, regardless of the agency distributing that information. The Showcase used the logo in all of its print material, including stationery for the project. Figure 20 shows the Traveler Information Showcase logo.

i Traveler Information Showcase
1996

Figure 20. The public relations program included developing a TIS logo.

Coordination with Private Sector

Showcase team members from the private sector were asked to coordinate their public relations and marketing activities with those sponsored by the Showcase itself. The purpose of this coordination was to ensure consistent communication about the Showcase to the public and media across all team members and to help reinforce everyone’s efforts to realize greater benefits than possible through individual actions. Coordination took the form of joint planning of a media event, shared press releases and presentation materials, and joint authorship of papers for presentation at ITS conferences.

Booths at Trade Shows

The Showcase supported the efforts of the public agencies which developed a display booth of Atlanta ITS projects to be shown at key industry conferences: ITS America, Institute of Transportation Engineers (ITE), Third World Congress on ITS, and the American Public Transit Association (APTA). The support included help with initial planning, providing Showcase materials for the booth, and assisting with logistical arrangements at the conferences.

Print Material

The Showcase produced a wide range of materials to promote the demonstration. Table 7 describes the print material developed for the TIS.

Media Relations Program

The media relations program was designed to be an ongoing effort to ensure that media coverage occurred before, during, and after the events of the Summer of 1996 in Atlanta. The media relations program was designed to help develop an awareness of the Showcase prior to the Summer of 1996; provide support for implementation during the Summer of 1996; and publicize the real-time traveler information story after the Summer of 1996.

Before the Summer of 1996, the following activities occurred:

- The transportation trade press, traveler magazines, Georgia media, and some national media received press kits and other mailings followed by several telephone calls to alert them about the Showcase (March through May)

Table 7. A Variety of Print Materials Were Developed for the TIS

NEWSLETTERS
■ Five editions of ***The Traveler*** were produced: July '95, December '95, February '96, May '96, and November '96 ■ Contents included feature articles highlighting different aspects of the Showcase ■ Distributed to a mailing list of more than 3,200, consisting of transportation professionals, public and private sector officials interested in ITS, journalists, and others throughout the United States. The newsletters also were inserted into press kits.
FACT SHEETS
■ Eight fact sheets were produced focusing on specific elements of the Showcase: general information. about the Showcase, personal communications devices, in-vehicle navigation systems, cable television, interactive television, the Internet, and user assessment. ■ Distributed in press kits given to the media and handouts at the Third World Congress on ITS.
PRESS RELEASES
■ Ten press releases were issued highlighting key milestones in the Showcase: December 6,1995-Introduction to the Showcase December 22, 1995-Revised introduction to the Showcase February 6,1996-Connection of Showcase to Operation Timesaver March 5,1996-Media advisory for May 14 preview March 20,1996-In-vehicle navigation systems April 15, 1996-Media advisory for May 14 event June 1,1996-Showcase systems initiated August 1,1996-Showcase operations during Olympics October 1, 1996-User assessment November 1996-Showcase legacy ■ Distributed to PR news wire service for release to national and regional media. Also included in press kits and mailings to journalists.
FLYERS
■ Two one-page information flyers aimed at the general public in Atlanta were created to raise their awareness of the Showcase (April 1996) and to promote usage of the Showcase cable TV and Website services (June 1996). ■ Distributed to employers who agreed to distribute to their employees and provided to GDOT for placement at their visitor centers.

- A one-day media event was held on May 14,1996 that introduced participating journalists to the Showcase technologies and included site visits. The turnout of journalists for the Showcase May 14 event was disappointingly low (nine) due in large part to the opening of the Olympic Stadium and a media event sponsored by Coca Cola that were scheduled on the same day. Journalists who were contacted after the May 14 event said they had been assigned by their editor to cover the Olympic Stadium event but would have preferred to attend the day-long Showcase event. Many of the contacts made to solicit participation prior to the May 14 event subsequently came to Atlanta to spend a day with the Showcase team during the four-month demonstration period.

- Writers knowledgeable about traveler information and intelligent transportation systems were commissioned to write articles for submission to trade press publications. These original articles were reproduced and distributed in press kits and public relations kits. These articles include: ***ITS World*** (January/February1996), "A Golden Opportunity" by Charles Snyder; ***Traffic Technologies International I996 Annual*** (January 1996), "A Preview of The Atlanta Traveler Information Showcase," by Jerry Pittenger; and ***Public Roads*** (Summer 1996), "Atlanta to Showcase ITS Traveler Information," by David Williams

- A media database of approximately 350 journalists was developed that contained information on key media contacts (local, regional, national, and international)

- A Media Resource Book that contained the contact names of 34 participating Showcase organizations was created in April 1996, with updated editions produced in May and July

- Broadcast-quality video footage was shot in May 1996, which provided a visual for "B-Roll" to be distributed to broadcast media (15 copies of the B-roll were distributed)

- Public Service Announcements (PSAs), written and provided to local radio stations, were aired on 15 Atlanta radio stations

- During the Summer of 1996, competition for media attention proved to be intense; Walcoff stationed a staff member at the Showcase office in Atlanta to serve as a central clearinghouse to field, screen, and coordinate media inquiries; with consistent mail and telephone efforts, the staff member helped achieve visibility for the Showcase during the critical period of media coverage of the Olympics and Paralympics in Atlanta

- Leading members of the media (print journalists, broadcast media, and columnists) were invited to personally experience the Showcase

- Eight local Atlanta radio stations conducted Jive and telephone interviews with FHWA and Showcase officials

- A media relations firm cultivated print and broadcast media interest in the Showcase on a national level

- Video "B-Roll" was produced and provided to the broadcast media to stimulate coverage

- Showcase talking points and themes were developed for distribution among team members so they could provide a cohesive view of the project when talking with the media

- Media and public relations guidelines were developed and distributed among team members and the media.

After the Olympics and Paralympics, efforts to bring print and electronic media journalists to Atlanta continued, as did outreach efforts to local press.

Media coverage of the Showcase was overwhelmingly positive. More than 100 major newspapers, magazines, and newsletters covered one or more aspects of the project. Among the major periodicals that ran articles on the Showcase were ***The New York Times, The Los Angeles Times, USA Today, The Atlanta Journal-constitution, The Christian Science Monitor, PC Week, Kiplinger's Personal Finance***

Magazine, The Milwaukee Journal-Sentinel, The Cleveland Plain Dealer, ITS World, and ***Ward's Auto World.*** A number of major news services including the Associated Press, the New York Times News Service, Knight-Ridder News Service and several syndicated columnists distributed articles to their subscribers across the country.

In the electronic media, more than 20 national and local network affiliate television programs broadcast segments on the Showcase. These included CNN, the Public Broadcasting Service, CNBC, Fox National News, the Discovery Channel, Good Morning America (ABC national), and local CBS and NBC affiliates in Atlanta and several other Georgia cities. The nationally syndicated "America on the Road" radio program (Mutual Broadcasting Network) interviewed Project Manager Jerry Pittenger in August, the nationally broadcast USA Radio News (1,700 affiliates) interviewed Deputy Project Manager Dave Williams on October 16,1996, and ABC national news interviewed Jerry Pittenger on November 13, 1996 for broadcast on World News Tonight. Showcase officials were interviewed by eight local Atlanta, Georgia radio stations. Major newspaper, magazine, and television coverage reached large audiences in Europe and Japan as well.

LESSONS LEARNED

By any standard, the Showcase fared very well at the hands of the media, especially during the summer when much of the Atlanta transportation infrastructure was called into serious question by the media. Coverage of the Showcase and the five demonstrated technologies was overwhelmingly positive. Experiences from this media campaign suggest a number of points and options for future projects to consider:

- **Personal contact with journalists through mailings and telephone follow up is an extremely effective method to develop interest iu this type of story.**

- **ITS is an exciting story for journalists if it is presented properly.** The public and journalists were intrigued by the five technologies, their capabilities, and especially the benefits for the traveling public.

- **There should be one point of contact for the media.** For projects such as the Showcase, where relationships and reality are constantly evolving, having a multitude of spokespersons can create a situation in which nonuniform information could be provided, resulting in inaccurate and eventually unfriendly **stories.** One voice can eliminate the confusion.

- **Include the public relations arms of team members early in the planning process so that a coordinated message can be developed, collateral materials can be collected for distribution, and synergies of resources and personnel can be explored.**

- **Plan for a relatively long lead time to develop the media outreach campaign.**

- **If media outreach is going to be conducted, funds for a clipping service and video archive services are essential to tracking coverage of the project.**

- **Have resources available in reserve for unexpected opportunities.** It is difficult to predict months in advance how media interest will materialize, and it is important to be able to respond when and where they want to cover the project.

- **Public relations staff involved in the project should be trained to demonstrate or promote the technologies in sufficient detail to handle the majority of media inquiries.** This training will avoid diversion of the technical staff into media relations functions.

Systems Testing and Engineering

OBJECTIVE

The goal of the systems testing and engineering activities was to develop a testing process that would evaluate the Traveler Information Showcase (TIS) systems, as operated by a typical user or group of users, in an environment as operationally realistic as possible, including the expected range of natural environmental conditions. In addition, the performance of testing would evaluate the operational effectiveness and suitability of the TIS, and measure the degree to which the various system(s) satisfy documented program requirements (Functional Definition Document, Interface Control Documents, and System Design Specifications), as well as implied user requirements. Ultimately, the goal was to deliver TIS systems that were operational and functionally sound to the Federal Highway Administration and to users in the Atlanta metropolitan area.

APPROACH

Several methodologies for testing the various systems and devices were considered, and weighed against unique factors encompassing the Atlanta TIS project. The diverse number of vendors, the technical challenges they faced, the design/build nature of the project, the geographically diverse development teams, and the compressed work schedule all affected which methodology and, ultimately, the approach taken to testing and evaluation. Overall, flexibility was the overriding factor, and contributed significantly in the final selection.

The TIS is an integrated system, designed to interact with (either in a send/receive mode or strictly a receive mode) and disseminate traffic and travel information to a variety of external Independent Service Provider (ISP) systems and devices. At the core of the TIS is the fixed-end server (FES), which processed information and requests, stored data, and interacted with the Advanced Traffic Management System (ATMS). ISP systems external to the FES, and subject to test, included the following:

- Motorola Envoy Personal Communication Device (PCD) using the ARDIS wireless network
- HP2OOLX Palmtop PCD using the SkyTel two-way pager network via an ETAK-developed Transportation Workstation (TWS) located in the TIS Operations (Room 307)
- Siemens/Zexel in-vehicle navigation system (IVS) using an FM subcarrier via a DCI-provided software network
- A cable television (CATV) channel via an ETAK-developed TWS to local cable providers and county or city public access channels
- Interactive Television (IATV) channel via an ETAK-developed TWS and Source Media to approximately 300 rooms in a hotel in the northern Atlanta metropolitan area (Crowne Plaza Ravinia)
- TIS Home Page (on-line server [OLS]) on the Internet via a Web server developed by Maxwell Laboratories.

The TIS systems and devices were commercial off-the-shelf (COTS) enhanced with newly developed software to provide value-added features for TIS functionality. The baseline features of the systems and devices, while providing users/clients with additional personal productivity tools and functionality, were not subject to direct testing and/or evaluation other than by observation.

The TIS test and evaluation program focused on the more extensive and detailed tests of the "value-added" functions, or those created uniquely for the TIS. The matrix shown in Table 8 shows how various segments of testing were performed for each system/device. Network services are the communications links between systems/devices. The FES and ISP servers were tested, where applicable, as part of the system/device testing.

Table 8. Testing Was Performed for Each System/Device

DEVICE/ SERVICE	BASELINE FUNCTIONS	TIS FUNCTIONS	NETWORK SERVICES	TIS SERVERS	
				FES	ISP
PCD	O	T	T	T	N/A
IVS	O	T	T	T	N/A
CATV	O	T	T	T	O/T
IATV	O	T	T	T	O/T
OLS	O	T	T	T	O/T

Note: 0 = Observation T = Testing N/A = Not Applicable

Before testing began, the team made several pre-test assumptions in order to meet testing and evaluation schedules. Any changes to pre-test conditions would have a direct effect on the testing and evaluation schedules. Pre-test assumptions included:

- TIS systems/devices and network services would be delivered and available for testing and evaluation on December 29, 1995, and system installation would be complete on December 31, 1995.
- Systems/devices would be delivered with all baseline and TIS-unique functionality
- "Normal" TIS network services and connectivity would be fully operational or capable of being simulated
- Sufficient simulated and/or live test data of anticipated network traffic would be available during the test period
- System/device functional specifications would be defined sufficiently to initiate requirements-based testing.

In addition, a series of critical test and evaluation issues were prepared to ensure technical and operational effectiveness, suitability issues, performance, interoperability, and functionality were properly addressed and would assess the system's capability to perform its mission:

- Verification of TIS baseline system/device performance requirements, system features, interoperability, and functionality
- Operational capabilities, including human factors (human-machine interface), evaluated by exercising procedures consistent with TIS functional requirements specifications and reasonable user expectations
- Operational testing focused on the value-added features of systems/devices as indicators of the TIS's fully mission-capable status. The features included interoperability (in ITS Atlanta), accurate and timely information to the user (value added), and benefit to the user (after completion of TIS, Summer of 1996, and during transition to legacy).

Alternatives Considered

Military specification (Mil-Spec) was considered because it offered a regimented, "bullet-proof' approach to testing. Unfortunately, its rigid, formal requirements for adherence to schedules and life-cycle development timelines offered little flexibility and would have placed an unsurmountable burden on the ISPs/vendors.

An Institute of Electrical and Electronics Engineers (IEEE) standards format was explored and, although still somewhat formal, it offered more flexibility and the ability to stagger the testing effort. This approach also adapted well to the design, build, and flow of the project.

Alternatives Selected

An IEEE format was used to form the outline for the Test and Evaluation Master Plan (TEMP) and the individual test plans for the systems/devices of the TIS. The following narrative provides an overview of the major testable elements in the TEMP and the requirements and approach taken.

Baseline Functionality

The test and evaluation of the baseline features of selected systems/devices was accomplished largely by observation (checklist) and reuse of vendor/independent service provider (ISP) test results. The in-vehicle navigation device was an exception to this approach, in that many of its baseline features were incorporated into the testing procedures of TIS functionality. A basic assumption was made that ISPs/vendors would deliver a fully functional product to Atlanta, and that they had performed developmental testing and evaluation prior to delivery. This was absolutely necessary due to the compressed schedule of the project.

TIS (Value-added) Functionality

Developmental testing and evaluation (DT&E) was the responsibility of the ISP, which was responsible for product acceptance tests, where applicable, for the COTS system/device they were utilizing. DT&E includes all salient characteristics about the item, including test conformance information pertaining to Operational Safety and Health Administration regulations, Commercial Standards, or Federal Communications Commission regulations. ISPs also were responsible for performing acceptable levels of testing to ensure interoperability, as outlined in the Interface Control Document (ICD) for their system/device, with the TIS FES-device interface, and the ITS Atlanta architecture.

The objective of the DT&E was to have the ISPs verify that the system software and procedures met the operational concept defined in the Functional Definition Document, the Interface Control Document, and the System Design Specification for their system/device. In addition, the ISPs were responsible for verifying that the communications network services were adequate to meet the operational and functional requirements of their system/device.

The scope of the ISP DT&E included:

- A system functional test, conducted to verify the functional capabilities of the device/subsystem as identified in the respective verification requirements traceability matrix (VRTM). The VRTM was developed to trace the required functionality of each system/device, and also included failure recovery and fault tolerance.

- A System Performance Test, conducted to verify the performance characteristics, response time, and system quality factors of the device/subsystem as identified in the VRTM.

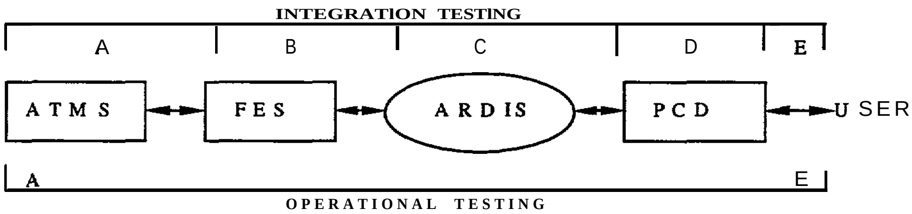
- A hands-on capability review, conducted to validate and verify functional performance against the subsystem Functional Requirements Specification and Interface Control Document.

- An FES/device Interface Test, conducted to verify compliance with the device/subsystem Interface Control Document.

Upon completion of DT&E testing, the individual ISP delivered its products for the operational testing and evaluation (OT&E) integration and operational (I&O) testing. Specific responsibilities for the SRC Test Team during this period included ensuring that testing and evaluation took place in an environment that was, as closely as possible, the actual operational environment in the ITS Atlanta and greater Atlanta metropolitan area during the period June 1,1996 to September 30,1996. In addition, this included ensuring that the I&O testing in the Atlanta metropolitan area was performed using actual ITS Atlanta and TIS subsystem interfaces. Other responsibilities included determining the readiness of people, procedures, software, and equipment necessary to perform testing and evaluation, test reviews, and pretest meetings; ensuring appropriate technical representatives were provided by each ISP to assist during these testing activities; providing periodic results during this phase of testing that included specific lists of defects, recommended action on fixes, and retest requirements; monitoring ISP test and evaluation activities during DT&E to determine the extent that their testing and evaluation verified functional requirements in preparation for OT&E I&O testing; at the completion of DT&E testing and evaluation, conducting the necessary evaluation to verify OT&E I&O requirements; and verifying integration interfaces and user functionality.

The objectives included verifying systems operations and interfaces, identifying deficiencies, evaluating system performance, and providing information to permit program refinement. Basic system operations tests were included in both integration and operational testing in order to verify that TIS requirements were met. This included testing functions of the interface across the range of operational conditions, performance testing in order to verify usability of the system/device display, ease of data input, and the overall use of the system. In addition, each system/device had to be tested to verify that no one system/device degraded the performance of the TIS/ATMS.

The testing was divided into two phases: subsystem/device integration testing and operational system testing. The testing team developed a separate chart for each system/device. Figure 21, which shows the testing chart for the Motorola PCD, illustrates how the integration testing phase tested each piece of the system until it was integrated, and how the operational testing phase tested the system/device in its operational mode (from the TMC to the user). During each of these phases, each system/device was tested against its VRTM developed from the Functional Definition Document.



INTEGRATION TESTING
- A: Simulate Test Scripts.TransView
- B: TransView Logs, "Trace Logs (UNIX) Monitor I/O Processing
- C: ARDIS Network (Monitor Message Reports)
- D: Input Received/Processed (S/W Monitor/log)
- E: User Interface

OPERATIONAL TESTING
- A: From the TMC
- E: To the User

Figure 21. Sample testing chart for the Motorola PCD.

Compliance to each system's/device's baseline and TIS value-added functional requirementswas verified by inspection, analysis, demonstration, and evaluation.

System/Device Integration Test.

System and/or subsystem/device integration testing consisted of systematically consolidating systems/ devices into the entire TIS system and culminated with an end-to-end system performance test.

Operational System Test

Operational system testing verified the operational effectiveness and suitability of the equipment and ensured that the systems/devices that were delivered did what they were supposed to do. The tests evaluated the operational performance in critical areas, tested the limits of performance, and provided operational performance benchmarks which were specified in the VRTM. Operational system testing categories included:

- System initialization (including degraded operational startup)
- Operations checkout
- Reliability, maintainability, and availability
- TIS load testing of all interoperable systems
- Human factors (human-machine interface)
- Communication throughput
- Performance monitoring (e.g., possible range of response times and average response times)
- Functionality
- Interoperability in ITS Atlanta.

TIS Reduced Operations Testing

Although the risk of total system failure was considered to be very low, two basic system failure scenarios were developed and evaluated. Emphasis was given to "loading" the system during OT&E to determine the risk, under each scenario, to the TIS system. The scenarios were TIS as "Showcase" during normal operations in ITS Atlanta, and TIS as "Showcase" using its own independent data sources (no ATMS, or various ATMS system failures).

Although the likelihood of a total ATMS/TIS failure was remote, the possibility that a portion of either system could fail and not recover within a pre-defined acceptable time limit was possible. The most likely potential failure modes, the systems they affect, and possible solutions or workarounds include the following, listed extensively in the TEMP:

- Human Error
- System Capacity
- ATMS Surveillance Data Loss
- ATMS Database (Loss of current ATMS traffic situation)
- ATMS Network and/or PBX Loss
- TIS Primary/Secondary Server Loss
- Individual ISP Component (TMC end and/or user end)
- Power Failure.

Where applicable, each was tested and/or evaluated.

System/Device Retest

Retesting of the entire or a subset of a particular system's/device's functionality was the joint decision of the project management staff and the FHWA project director, after the test team's report. Retesting criteria was based on how severe the function failure was and how it affected the ability of the TIS to meet its operational goals. Function failures were put into two categories. Relevant failures were those that had a direct impact on TIS functionality, while *nonrelevant failures* did not necessarily affect TIS functionality directly but could affect the overall outcome and/or functioning of the system/device and, therefore, the TIS program.

Human Factors/User Evaluation

Evaluation of human factors items was accomplished in two ways. First, during the testing and evaluation of the systems/devices, the SRC field testers, in conjunction with the ISP representatives, assisted in the verification and usability of the TIS displays, ease of use, portability, and adaptability to receive all types of designated inputs. Second, before and during the actual TIS period, a plan was developed for the recruitment of users, training, and the assessment of the users' experience. User feedback was solicited through surveys, personal interviews (telephone or debriefing upon return of the device), and mailback questionnaires.

IMPLEMENTATION

Before executing the Test Plan for each system/device, the team established the following assumptions:

- Each system/device would be delivered for testing within the time frame specified by the TIS program schedule

- Developmental testing would be accomplished by the ISP's staff with observations by the test team and that documentation would be provided

- Software to support all the TIS features would be included (a complete system).

Some flexibility had been built into the schedule to accommodate the sequencing of testing for each of the TIS systems/devices. Also, because the developers' schedules and the definition (and in some cases the design) of the communications interface was a significant effort, delays were almost inevitable. Therefore, comprehensive testing of the communications software and newly implemented communications hardware and network services was required. The testing of the devices with the FES was to be initiated early in the testing sequence to determine if there were any major interoperability problems.

The vendor development teams were widely dispersed geographically, which required that the progress of the software development and subsequent testing was monitored by on-site reviews at the developers' facilities. The full functionality of each system/device was tested independently with the FES using the specified communications interface and network server. Each system/device was then integrated into the test bed with other systems/devices. The goal was to exercise the FES fully and to ensure that each system's/device's operability was not impacted by another system/device. The test team developed test plans and procedures that addressed both functionality and reporting. Unfortunately, the delay in the delivery of systems/devices and the FES, which were scheduled for delivery in mid-to-late January 1996, delayed the testing and evaluation process and necessitated a compression of the schedule.

The ISPs did not deliver their products as scheduled, on December 31, 1995. Periodic releases of partial functionality were delivered for testing during March and April. These delays had an impact on the testing strategy, and the team had to adapt the testing environment. The complexity of the environment and the interdependancies of the external systems also created a high level of concern.

The developmental and system/device integration testing phases were collapsed into one effort, and the test team proceeded to test the system/device functionality as it was delivered. Problem reports were generated for all deviations and/or failures to meet FDD requirements. The testers became part of the development team, reviewed the implementation, and participated in the technical sessions to help expedite the resolution of outstanding problems.

The TIS team worked with the ISPs to ensure that the testing, product enhancements, bug fixes, and other related activities progressed quickly. The test team worked with the developers to analyze and debug the data transmission, and when necessary delved into the complexities of the communications networks (ARDIS, SkyTel Paging, and PM subcarrier).

In spite of the delays and the complexity of the situation, the testing team adapted to late deliveries and the majority of functionality had been demonstrated after two months of attempts to test fully.

Because of the compressed schedule, the development, integration, and system testing were being executed concurrently. Also, every effort was made to accommodate the interjection of revisions and/or enhancements into the test cycle. The final design/build/testing phase was accomplished, and all systems were operational on June 1, 1996. The systems continued to operate with few "major" **problems throughout the Showcase period. The test team continued to provide support during the** Showcase operations period by testing/verifying new and/or revised software and hardware interjected into the operations.

LESSONS LEARNED

Several important lessons emerged during the systems testing and evaluation of the Showcase:

- **Technical documentation is essential.** Because no system had been built like this before, and because of the time constraints on the project, knowing exactly what was needed and/or required was somewhat difficult. However, in the future, every effort should be made to define the system through technical documentation (requirements definition, system functional specifications, detailed design specifications, interface specifications, and test specifications) early in the project to avoid any confusion from designers, developers, integrators, and operators. Creating these technical documents early in the project avoids major deviations from the life-cycle development of the product and ensures compliance with original requirements and expectations.

- **For testing and evaluation to be effective, project stuff must be carefully coordinated.** This becomes even more critical when the development team is as geographically diverse as they were in the Showcase project. The test and evaluation team must be integrated into every facet of the product development and project decision-making process. This integration will help to ensure that any changes in design or development criteria, expected and/or unexpected delays in schedules and deliveries, and any other critical project requirements are understood and coordinated with the entire team. Close coordination among all members of the team must continue the entire length of the project to ensure continuity and cohesiveness. In addition, all testing should be performed in one location, preferably on the project site. Much better progress was made when the entire team-developers (ISPs), task leaders, and testers-was brought together. Geographical separation of team members during the testing process delayed response times to the corrective action.

Communications Infrastructure

Communications Infrastructure

The Traveler Information Showcase required an extensive communications infrastructure to disseminate reliable, up-to-the-minute traffic information to travelers in the Atlanta metropolitan area. This section reviews the objective of the Showcase communications infrastructure, and examines for each Showcase technology the approach taken, including alternatives considered and alternatives selected, the implementation, and the lessons learned.

OBJECTIVE

The objective of the TIS conirnunications infrastructure was to provide current traffic information expediently and reliably to a variety of systems and devices, including vehicles equipped with navigation units, pedestrians with personal communications devices (PCDs), cable television viewers, Internet users, and hotel guests.

APPROACH

Selection of the communications technology used for each TIS subsystem was left up to the individual ISP teams. Specific requirements included data rates necessary to provide the needed information to the user, coverage of the wireless system (if applicable) for the entire demonstration region, and the availability of the wireless system and service provided by the system in the demonstration region. The alternatives considered and selected for each subsystem are discussed below.

In- Vehicle Device

The in-vehicle device selected for the Showcase project was the Siemens/Zexel navigation device. The device had a serial port available for accepting traffic information from an outside source, which left a variety of wireless solutions available for the transmission of the traffic data.

Alternatives Considered

Three wireless technologies were investigated for the in-vehicle device: one-way pagers, cellular modems, and PM subcarrier. The first alternative would use an existing one-way pager network to provide traffic information to the in-vehicle device. The pager would be able to provide brief messages to the navigation devices using a special cable to connect the two devices. This solution would require very short and concise messages because of the bandwidth restrictions of a paging network. Additionally, the network would have to be able to support the additional traffic of Showcase users without injecting long delays into the delivery of the information.

The second alternative required the use of a cellular network and a cellular modem to deliver the information to the navigation device. The cellular modem would have to be equipped to deal with the problem of "hand off' which occurs when the customer changes cells during a communications exchange. Also, the data would have to travel over the existing analog cellular network because digital cellular would not be in place in time for the Showcase demonstration.

The third alternative was the use of PM subcarrier. This technology uses subcarriers already present on the major carriers in the spectrum designated for PM radio (88.1 MHz to 107.9 MHz) for the transmission of digital data Use of these subcarriers enables traffic information to be carried digitally and silently by means of a Traffic Message Channel without interfering or interrupting the audio portion of the PM broadcast. A special receiver in the vehicle receives this information and provides it to the navigation unit.

Alternatives Selected

PM subcarrier transmission was chosen over cellular and pager solutions for several reasons. PM subcarrier transmission on multiple radio stations provides a technological solution that is proven, reliable, easy to implement, and operable during the legacy. PM subcarrier has significant legacy appeal. Because most automobiles built today are equipped with PM receivers, it would be easy to integrate reception of traffic information via PM subcarrier into the production of new automobiles, giving everyone the advantage of the intelligent vehicle concept. Several active PM subcarrier networks were broadcasting differential Global Positioning System (GPS) corrections. Because the Radio Broadcast Data System standard (RBDS) had defined traffic messages as well as DGPS messages, it would be easy to use the current networks to broadcast traffic messages similar to the European implementations. Even though the in-vehicle system was modeled after previous systems, software development was required to support the transmission reception and message handling of traffic information. This development included determining the communications interface protocol, defining the message sets, and determining update frequencies, message processing, and user presentation.

Additionally, PM subcarrier was designed for the transmission of digital data, unlike the cellular solution that uses an analog network to transmit digital data. Thus PM subcarrier would be a more reliable solution. PM subcarrier also could address a fleet of vehicles more easily than cellular. The cellular solution could not offer a way to broadcast one message to a select group of cellular customers efficiently. A server would have to dial all the customers individually every time there was a traffic update, which would be a very expensive and inefficient solution, especially when there is no guarantee that the cellular system being dialed is even in use at the moment. With the PM subcarrier, however, once the receiver is turned on the device will get the next update as it is broadcast. Although the paging solution could address a fleet of vehicles, it too was inferior to the PM subcarrier solution. Due to existing traffic on the network, the bandwidth of the paging solution was restrictive for the amount of data that would be broadcast during a typical rush hour period. Since PM subcarrier could provide the required bandwidth, it was the obvious choice.

Personal Communication Device

The selection of the communications technology used for the personal communication devices (PCDs) was largely dependent upon the PCD device that was selected. Initially a high-level set of requirements were developed, and the vendors were asked to present a proposal for the TIS personal communication device technology demonstration. Specific requirements included data rates necessary to provide the needed information to the user, coverage of the wireless system for the entire demonstration region, and the availability of the wireless system and service provided by the system for the demonstration region.

Alternatives Considered

Each vendor considered was asked to propose a PCD, PCD TIS software, and a wireless communications network solution. In every case, the vendors formed teams to arrive at a solution. Table 9 shows the teams that submitted proposals to the Showcase project.

Table 9. **Several Teams Submitted Proposals for the TIS PCD**

TEAM NAME	SOFTWARE	PCD	NETWORK PROVIDER
Bell South Cellular	Xetron (Westinghouse)	Bell South Simon	Bell South
Loral	Loral	Marco (Motorola)	ARDIS
Fastline	Fastline	Envoy (Motorola)	ARDIS
Maxwell Technologies	Maxwell	Apple Newton	RAM
Psion	HOLOS	Psion	RAM
*Peachtree paging	ETAK	HP200LX	SkyTel two way

* Submitted proposal after a previously selected team dropped out.

The Showcase team evaluated a number of technologies before selecting the wireless communications for the PCD. These technologies included wireless packet radio networks, cellular networks, and two-way paging networks, with selection based on the PCD capabilities, cost of memory, development time, funding, and networking options. The wireless networks available in Atlanta in early 1995 had limited bandwidth and were not designed for high-speed transfer of large data blocks. Additionally, the PCDs had limitations (i.e., memory, connectivity). These factors were taken into consideration by the vendors in the PCD wireless communications selection.

Alternatives Selected

The Showcase project team selected two PCD solutions in an effort to reduce the risk associated with the PCD venture. The Fastline team, comprised of the Motorola Envoy PCD, the ARDIS packet radio network, and Fastline software, was selected, as well as the Bell South team, comprised of the Bell South Simon PCD, Bell South Cellular network, and Xetron software. Unfortunately, Bell South was forced to drop out of the Showcase project when they learned that the Bell South Simon was to be discontinued from their product line. Because of this, the Showcase project accepted a proposal from an ETAK-led team comprised of the HP2OOLX PCD, SkyTel two-way paging network, and ETAK software.

The packet radio and paging networks selected used very different technologies, but shared some common limitations. Both had bandwidth restrictions and both required short bursts of small data blocks. Therefore, the system had to provide comprehensive traffic information that would be useful to the public with minimal transfer of data Compression techniques, local storing of information (PCMCIA cards), and the use of reference codes (abbreviated street names) were implemented to reduce the amount of data transferred from the TMC to the PCDs.

Envoy PCD. The Motorola Envoy used the ARDIS radio network to communicate with the Showcase fixed-end server. The ARDIS system was initiated in the 1980s as a joint venture between Motorola and IBM to provide wireless data access to IBM's field service technicians. ARDIS, developed from the ground up as a wireless system for the distribution of digital data, operates in the 800 MHz frequency band on a regional basis. There are two separate frequencies for the receive path and the transmit path, and both paths transmit data at fixed rates and include data bits as well as error detection and correction bits. Together, the two paths create a full duplex channel for data transmission. Today, ARDIS is expanding to provide national coverage by leasing frequencies from the

Federal Communications Commission (FCC) and selling subscriptions to their user/customers. The applications currently on the network involve user messaging (e-mail), point-of-sales, telemetry, and database queries. All the applications involve short bursts of data where the user is charged by the packet, which limits the type of applications that could be cost-effectively implemented on the network. Data compression techniques and local storage of information in the Envoy's PCMCIA card were two techniques used to reduce the amount of data transmitted.

Hewlett Packard 200LX PCD. The ETAK/HP team proposal was selected after the BellSouth team dropped out, of the project. The ETAK/HP team proposed a solution involving the HP2OOLX palmtop computer, the SkyTel two-way paging network, and custom Showcase software developed by ETAK. ETAK also was responsible for designing and implementing an intermediate traffic workstation to communicate with the fixed-end server. The SkyTel two-way paging network was a new, unproven, wireless network in the Atlanta region. The HP200LX was connected to a Motorola two-way pager to gain access to the SkyTel network. Once again, there was limited bandwidth available so data compression and local storage were used to reduce the amount of data transmitted over the network.

On-line Services

The Showcase Web page offered Internet users access to current Georgia traveler information to assist them in planning a trip to the Atlanta vicinity. A communications link to the Internet was required to give the public access to real-time traffic information, itinerary planning, transit, and wide area travel information, as well as to provide links to other Web pages pertinent to travel in the Atlanta metropolitan area.

Alternatives Considered

There were several considerations in determining the communications infrastructure for the on-line services portion of the Showcase project. The team knew that an intermediate server, called the Web server, would be used to connect to the Showcase fixed-end server, and there were options available to the team to make the connection. The first option was a low-speed direct serial link to the fixed-end server using RS232 running either 9600 or 19200 baud. The other option was to use an ethernet local area network (LAN) to connect the two servers, which would allow for theoretical data rates of 10 Mbytes per second. Several options also were available to connect the Web server to the Internet: a T1 line, a T1 line partitioned into channels, or a 56 kbit line.

Alternatives Selected

Maxwell Technologies was selected to fulfill the Showcase on-line system requirements. Maxwell Technologies was required to provide a computer platform to serve as a Web server, the software to act as the Web site, the software to interface with the fixed-end server, and the equipment necessary to access the Internet. Maxwell Technologies proposed a solution that included a T1 Internet connection into the TMC and the ethernet LAN connection from the Web server to the FES.

Interactive Television

The Showcase project wanted to be able to provide an interactive television system for Atlanta visitors staying in an area hotel. The existing cable television network would have to be able to handle the installed interactive television system. The user would select the Traveler Information Showcase channel, using the television remote control, to receive real-time traffic, hotel information, points of interest, yellow pages, and routing information. The user also would be able to print maps from the hotel room for pickup at the bellhop's desk. An intermediate server, known as a traffic workstation, would be used to connect the hotel server to the fixed-end server.

Alternatives Considered

Two methods of connection were considered for the link between the fixed-end server and the traffic workstation. The first was a direct serial link running RS232 at 9600 baud. The second alternative was to use an ethernet LAN connection. The communications link between the traffic workstation and the hotel server also needed to be determined. One option used a dial-up line from the Traffic Management Center to the hotel head-end server. Another option employed a dedicated leased line from the TMC to the hotel.

Alternatives Selected

Because the amount of data to be exchanged between the fixed-end server and the traffic workstation was not that substantial, the direct serial link was employed. This direct serial link was an RS232 link running at a speed of 9600 baud using the TRW landline data system (LDS) interface specification. For the interface between the traffic workstation and the hotel server, the dial-up method was selected. Because this was not a permanent installation in the hotel and a full-time connection to the hotel was not necessary, the dial-up line made the most sense. It would be the most cost-effective solution and would meet all of the requirements for the interface in terms of data throughput.

Cable Television

The Georgia Traveler cable television program was required to provide up-to-the-minute traffic information to the general public via local cable television providers. The Showcase project had a small production studio located in the TMC to integrate live traffic videos, traffic speeds, incident information, pre-canned video and audio clips, and live audio for distribution to Georgia Public Television (GPTV).

Alternatives Considered

Because the cable television would use the same traffic workstation that was used by the interactive television, the same selection process was used to determine the connection between the fixed-end server and the traffic workstation that was described above. Two communication links remained to be specified: the link between the traffic workstation and the presentation computer and the link from the presentation computer to GPTV. The two choices for the first link were a low-speed direct serial connection or a higher speed ethernet connection. Two alternatives for the second link were to use a fiber optic connection from the TMC broadcast room to GPTV, or to employ a satellite link between the TMC and GPTV.

Alternatives Selected

The link between the fixed-end server and the traffic workstation was to be a direct serial connection, so it made sense that the link between the traffic workstation and the presentation computer should be a direct serial connection. There was certainly no need to place a faster interface downstream of a slower one. The other link proved to be the more interesting decision. At first it appeared that the fiber optic backbone that would supply traffic surveillance footage to the local Traffic Operations Centers (TOCs) and GPTV might not be completed in time for use by the Showcase cable television program. This left satellite distribution as the only available means of connection between the TMC and GPTV. However, the fiber optic backbone was put in place in time for the cable television system and was subsequently used as the means for distributing the cable broadcast to GPTV.

IMPLEMENTATION

In- Vehicle Device

The Showcase project provided a one-way broadcast transmission of traffic information to a fleet of Siemens in-vehicle devices. The information was prepared by the Showcase fixed-end server and transmitted over a frame-relay network to a satellite up-link site in Raleigh, North Carolina. The information gained entry to the frame-relay network leased line through a frame-relay access device (FRAD) combined with a digital service unit/ channel service unit (DSU/CSU), both located in the TMC. The signal was then transmitted via satellite to six FM radio stations in the Atlanta area, all equipped with ku-band downlink receivers. At the individual stations, the data were formatted for broadcast over FM subcarrier, a process that uses a pre-processor to strip packetizing information and an encoder to format the data into messages acceptable for sideband broadcast. The station's exciter then incorporates the traffic message into the normal FM stereo broadcast. Differential Corrections Incorporated (DCI) provided all the necessary broadcast equipment and networks for the transmission of this data. A DCI receiver mounted in the trunk of the vehicle stripped the traffic information from the FM broadcast and sent the data to the Siemens device via a serial RS232 link (Figure 22). The in-vehicle device received the data, processed it, and displayed incident information, speed information, and maintenance information to the driver on the visual display unit mounted in the cabin of the vehicle. Figure 23 shows the flow of data for the in-vehicle system.

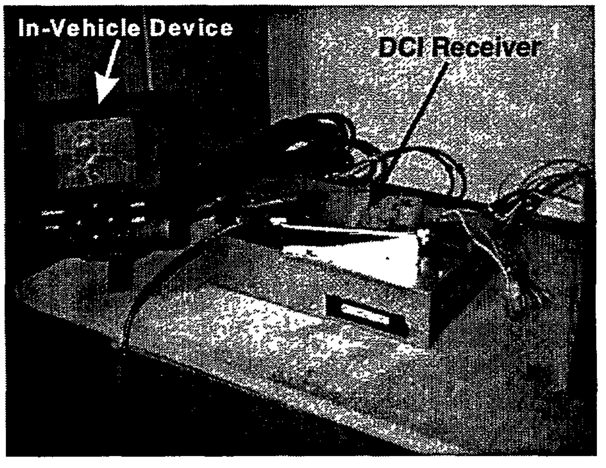


Figure 22. A DCI receiver mounted in the trunk of the vehicle sent data to the Siemens in-vehicle device.

The broadcast of digital data over FM subcarrier is defined by the Radio Broadcast Data System (RBDS) standard. This technology uses subcarriers that are already present on the major carriers in the spectrum designated for FM radio (88.1 MHz to 107.9 MHz). Use of the RBDS carriers enables traffic and travel messages to be carried digitally and silently by means of a Traffic Message Channel without interfering or interrupting the audio portion of the FM broadcast. The standard was defined to allow expansion of the broadcast capabilities for future growth and provide some flexibility for new applications. The standard defines message groups that are used to broadcast traffic information, radio text, and transparent data. Data is transmitted synchronously at 1187.5 bits per second as double sideband, suppressed carrier AM, centered at 57 kHz in the baseband. An average of 11.4 message groups are transmitted per second. The DCI network reserved a portion of the bandwidth for transmission of differential GPS correction messages, leaving the Showcase project approximately six messages per second.

The FES to in-vehicle route guidance device communication link used a derivative of the International Traveler Information Interchange Standard (ITIS) RBDS Bearer Application Protocol (RBDS-BAP) standard and a subset of the ITIS message list. Some modifications were made to the ITIS message

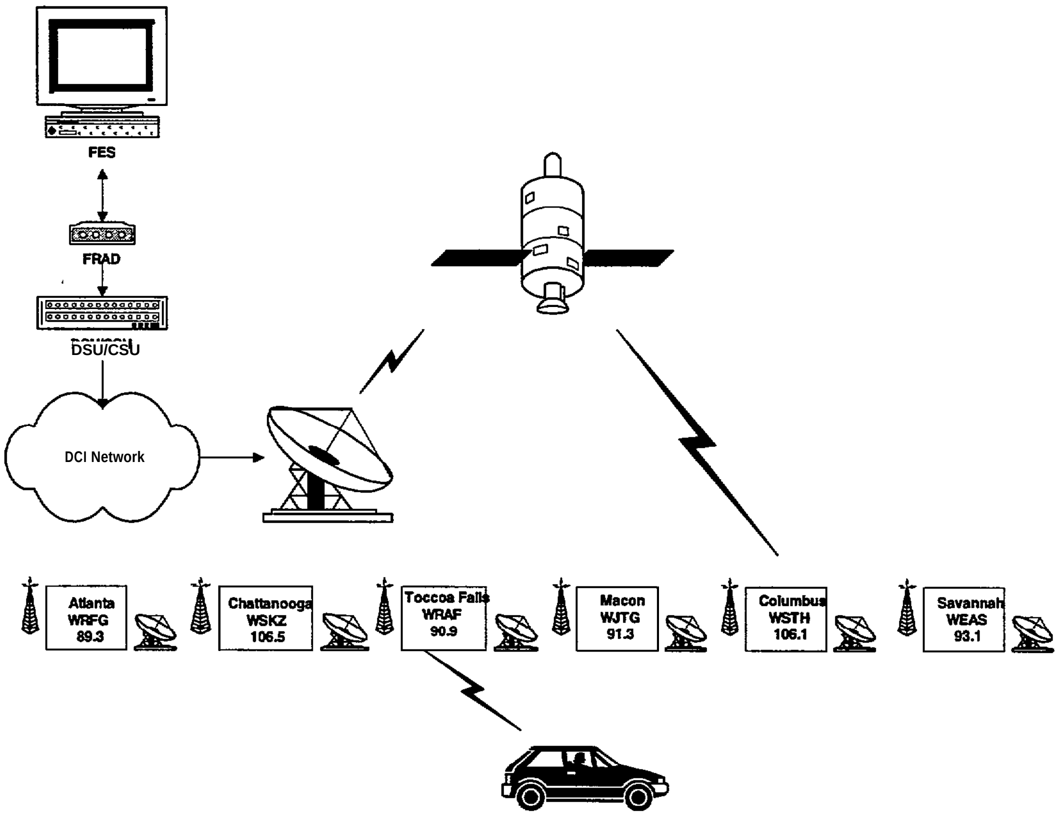


Figure 23. Data for the in-vehicle device was prepared by the FES and transmitted over a frame-relay network to a satellite.

set to accommodate specific needs of the Showcase project. The ITIS message list was developed to disseminate traveler information without regard for the broadcast medium. The RBDS-BAP specifies the exact format of these messages for FM subcarrier broadcast.

Personal Communication Device

Envoy

The Envoy PCD received all the traffic-related data and route requests via the ARDIS packet radio network. Once a traffic packet was formed for a target Envoy by the fixed-end server, it gained access to the ARDIS network through a dedicated PC equipped with an Eicon board and RF Gate software. ARDIS supports a direct connection from the user's host, in this case the dedicated PC connected to the Showcase fixed-end server, to their primary network host via a high-speed X.25 connection. The traffic packet is then routed to one of the main ARDIS switch locations. The ARDIS Network has digital wireline interconnections at switch locations in Lincolnshire, Illinois; Lexington, Kentucky; and Los Angeles, California; and at the major network hubs. During the initial evaluation phase, ARDIS presented their existing network transmission capability (MDC 4800 protocol), operating at a maximum of 4.8 kbit/s with a throughput that may not exceed 2.4 kbps. Currently, ARDIS is deploying 19.2 kbps transmission capability (RDLAP 19.2 protocol) in the Atlanta area. This capability was tested and significantly shorter transmission times were observed.

Built into the Motorola Envoy is the Motorola MD 4800 radio modem that can operate at speeds up to 19.2 kbps. An Envoy user initiated a traffic request by touching a button on the touch-sensitive screen. The request was formulated and broadcast via the radio modem. The radio modem had the ability to connect to multiple ARDIS base stations simultaneously. (A base station is composed of an antenna and a transmitter/receiver.) All the base stations that received the request forwarded the message to the ARDIS radio frequency/network control (RFNC) through a dedicated telephone line leased from the local exchange carrier. A complex sorting algorithm determined which one of the requests received from multiple base stations had the most signal strength. The RFNC remembered this base station and directed any outbound messages to the radio modem through this base station. The traffic request was then sent to a main switch location equipped with an ARDIS service engine. The service engine checked subscription information and routed the request to the dedicated PC located in the TMC. The dedicated PC stored the modem ID and passed the request to the fixed-end server. The server analyzed the request, prepared a response, and sent the response back to the PC. The PC verified the modem ID and issued the response over the ARDIS network. The response went back to the main switch location from which the request came and was sent back to the RFNC. The response was then broadcast, using the base station that the RFNC remembered as being the best one, and was received by the radio modem in the Envoy. Figure 24 shows the signal flow for the Envoy PCD system. Only the link from the radio modem to an ARDIS base station was wireless. The remaining infrastructure was a wire line backbone comprised of high-speed T1 and T3 digital communication links using dual path and redundant routing techniques.

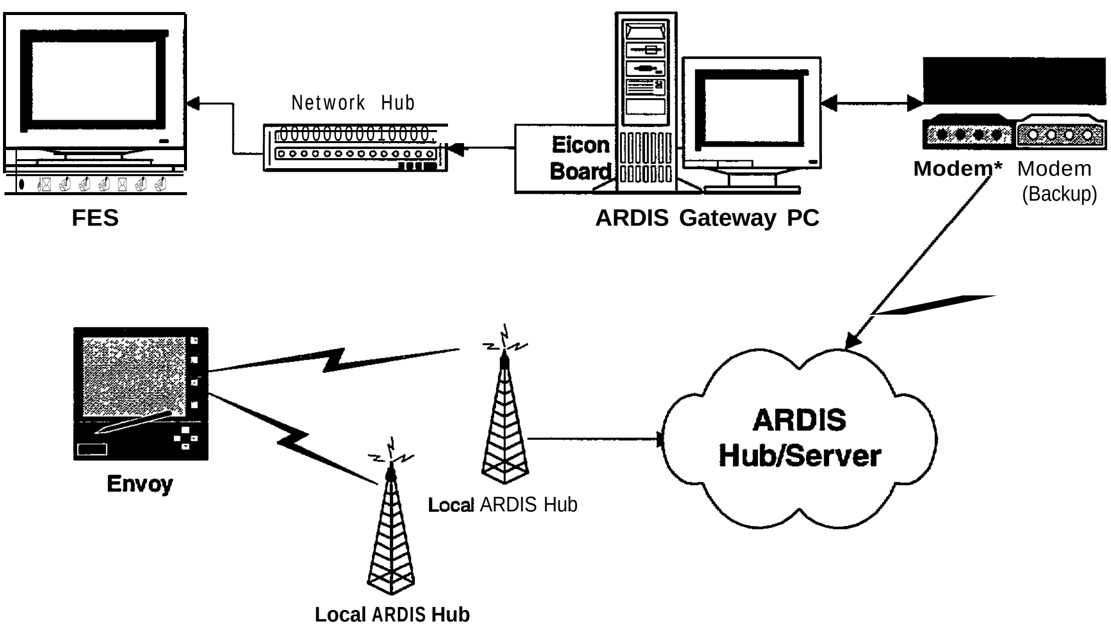


Figure 24. Envoy PCD received data via the ARDIS packet radio network.

HP2OOLX

The HP2OOLX is an MS-DOS-based PCD system which provides numerous business and personal applications. To receive traffic-related Showcase information, the system was coupled with a Motorola two-way pager that used the SkyTel network. This was a two-way transmission with full error correction using a store-and-forward type network. Therefore, transmission delays occurred during the wireless communication and at the SkyTel Network Operations Center (NOC) store-and-forward system in Jacksonville, Mississippi. A leased line connected the TIS ETAK Transportation Work Station (TWS) to the SkyTel NOC. The TWS, an intermediate server, was used between the SkyTel NOC and the Showcase fixed-end server to increase the reliability and availability of communications.

A user's traffic request was received by the nearest SkyTel tower, which then sent the message to the SkyTel NOC where it was stored in a special TIS mailbox. The ETAK TWS polled the mailbox every 15 seconds for user requests that needed to be serviced. The requests were retrieved and answered by the TWS, and the reply was sent back to the SkyTel NOC where it was broadcast by all the SkyTel towers. The TWS received up-to-date traffic information from the Showcase fixed-end server every time there was a change in the information, which ensured that the TWS always responded with the most current traffic information. All messages, whether requests or responses, were streamlined to minimize data transmissions, control cost, and reduce delays. Also, the HP200LX stored a great deal of its information locally to further reduce data transmission. The HP200LX system configuration is shown in Figure 25. During the rush hour period the TWS sent a broadcast page every 15 minutes with the current traffic information. A special "Cap Code" used by all the Showcase pagers allowed the TWS to mass address a cluster of pagers at one time. (The Cap Code is a number on the outside of the pager that identifies the tones or digital codes that gives the address and other information on the particular pager.)

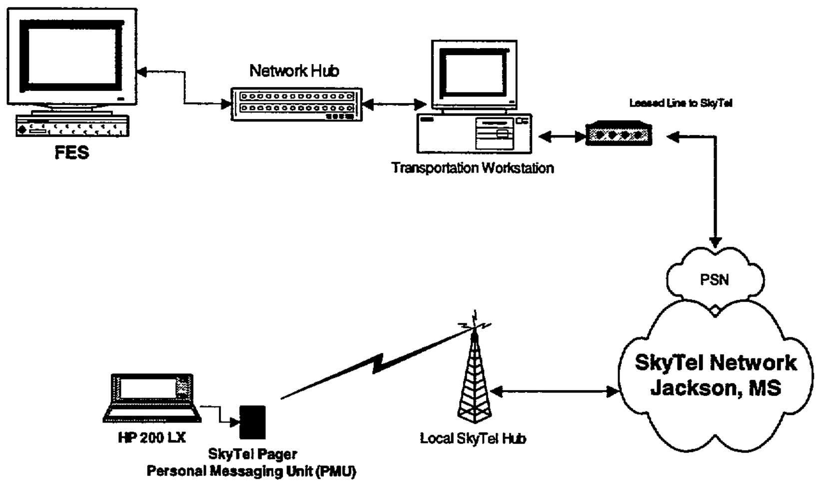


Figure 25. The HP200LX system was coupled with a Motorola two-way pager that used the SkyTel network.

On-Line Services

The heart of the Showcase Web site (www.georgia-traveler.com) was the TIS Web Server, a pentium PC platform which resided in the Traffic Management Center and was connected on a LAN to the TIS fixed-end server. The Web server was updated periodically by the fixed-end server with the latest traffic information via this LAN connection. Route requests, however, were handled on an individual basis by the fixed-end server in a manner similar to the Envoy PCD route requests. The Web server in these instances acted as an interpreter between the fixed-end server and the user. The Web server received the traffic and route guidance information from the FES and distributed it to the Internet users via a high-speed dedicated T1 (1.544 mbps) communications link to the local Internet provider known as PeachNet. A typical hardware setup comprised of a DSU/CSU, a network router, and a network hub was implemented from the TIS Web server to the leased line (shown in Figure 26).

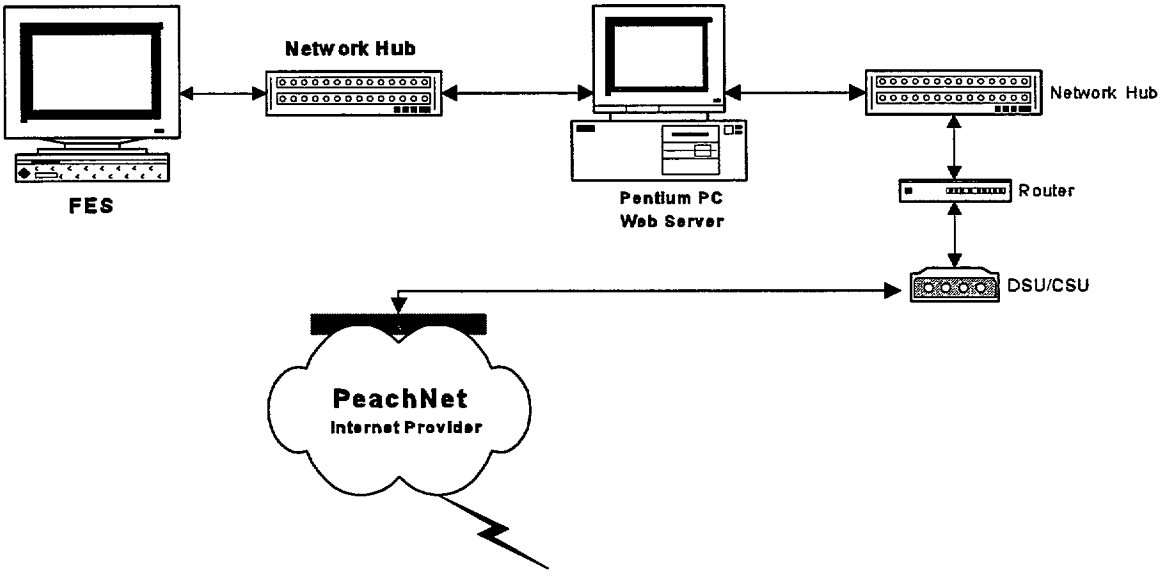


Figure 26. The Pentium PC Web Server provided the heart of the Showcase's on-line system.

Interactive Television

The Showcase interactive television service was available in nearly 300 rooms of the Crowne Plaza Ravinia Hotel in Atlanta. A customized version of Spectravision interfaced with the hotel's cable television service. Each room had a special "set-top box" and a handheld remote device that initiated the request to the interactive television system using the room telephone line. The user selected the Traveler Information Showcase channel to receive real-time traffic, hotel information, points of interest, yellow pages, and routing information. An intermediate traffic workstation, located in the TMC, connected to the hotel on a dial line and periodically downloaded traffic speed and incident information when it was updated by the TIS fixed-end server. The head-end server (HES), located in the hotel, processed the user's real-time traffic requests and displayed traffic data on Atlanta-area overview maps. This interactive television configuration is shown in Figure 27.

Cable Television

The Showcase cable television program used one of the 16 fiber optic channels that GPTV uses to get surveillance footage from the TMC to broadcast the signal to GPTV for distribution via their satellite network. The Georgia Traveler program is distributed to several cable television stations that service approximately 300,000 homes (Figure 28).

LESSONS LEARNED

Several lessons emerged during the development of the communications infrastructure:

- **Install and test early.** The GDOT Transportation Management Center's communications infrastructure was being implemented in parallel with the TIS implementation. The Showcase dependencies on the availability of the TMC communications equipment and services caused some delays. Also, final decisions and financial agreements with the vendors required extensive negotiations which delayed the activation of the network services. Additional planning and early installation of the communications network services and equipment would have helped to ensure that the communications were fully operational when the systems were ready for testing.

- **Prototype the network interfaces.** Protyping-specifically the message sets-would have helped in debugging the interfaces and analyzing the message loading on the networks. After the initial testing, data compression and modifications to the message structures were required to reduce cost and improve the throughput on the wireless networks.

- **Centralize control of tbe ordering, installing, and billing of communications equipment and network services.** Establishing the centralized control would have expedited the implementation and testing phase. Some of the Independent Service Providers (ISPs) provided the interface with the communications vendors and were responsible for ordering equipment and services. This created a problem with control and coordination.

Information Distrubution

The information distribution portion of the Traveler Information Showcase (TIS) was approached as six separate but integrated projects. The number one priority of the U.S. Department of Transportation (DOT) at the beginning of the TIS development work was the successful deployment of a Personal Communications Device (PCD). In order to minimize the risk associated with the software development and deployment required for the PCD, the team agreed to contract for two separate PCD applications so that if one failed to deliver, the second development effort would still meet the goal of fielding an operational device. The other technology areas included in-vehicle navigation devices, an Internet application, cable television, and interactive television.

Four critical factors were considered in selecting the vendor teams to develop and provide the applications:

- **Short Development Time.** Any potential vendor team interested in participating in the TIS had to agree that all development and implementation work could be done in a very short, compressed time frame. Final ISP selection was not completed until May/June, 1995, which allowed only six to seven months of development time before vendors were required to have their products available in Atlanta for the beginning of integration testing.

- **Commercial Off-the-Shelf (COTS) Technology.** The TIS project emphasized the use of COTS technologies whenever possible. Because of the project's short development time frame, there was not time to do "typical" software development life cycle activities. Each subsystem had to be developed using a design-build-design-build approach. Thus, to increase the likelihood of success, the vendors' ability to employ COTS technology in their applications was essential. However, even with the strong emphasis on COTS technology, some areas still required significant software development and hardware integration activities. The cable television and the two PCD subsystems required the most development and integration work. COTS applications that **suited the needs** of the **TIS** simply did not exist in the **Spring of 1995.**

- **In-Kind Contribution.** Because the TIS was established to be a public-private partnership, in-kind contributions were required on the part of each ISP "team." While no predetermined limits (either dollar value or percentage of total cost) were established for the TIS, the TIS Policy Committee made it clear that *all* vendor teams must make a significant in-kind contribution of hardware, software, or development work to be included as part of the TIS project team.

  In-kind contribution is not simply a one-way street. The private sector investment of hardware, software, or personnel time must have a return: they need to see something that points to the future and to the ability for this type of investment to provide a "return''-they have to be able to make money. As a result, in the contractual negotiations that took place for the TIS, several vendors required "ownership" of code or applications developed as part of the TIS. In every case, the vendors were willing to work with the U.S. DOT to keep the systems operational, but they were not willing to release all the source code into the public domain. This ownership requirement was most evident in the Internet and cable television applications.

- **Standardized Development.** Although each ISP development effort was treated as a separate "project" as much as possible, there were certain elements of each system where consistency between systems was desirable. Icons used to display traffic information (accidents, road construction, travel speeds) required significant integration effort to standardize. This required compromising between the COTS approach mentioned earlier (and the use of icons already available within existing applications) and the desire for all "information" to be displayed to users in a similar way. Not only was consistency among TIS applications of interest, the TIS was also asked to integrate these icons with the kiosk project as well as GDOT's ATMS project wherever possible. One of the major roadblocks in implementing a "standard" set of icons among all applications was the different display capabilities of each device. Information had to be displayed on everything from a very high-resolution computer screen (for the kiosk and some Internet applications), to a four-inch square display screen in a moving vehicle, to a small, black and white display screen on the PCDs. Table 10 provides the icons used by each device for each different type of traveler information.

Table 10. The Showcase Team Worked to Standardize the Icons Used in the Systems

Speed Categories	Fastline PCD	HP200LX PCD	In-vehicle Device	Cable Television	Interactive Television	Internet
0-10 mph						
10-30 mph						
30-50 mph						
>50 mph	Map Default	Map Default	Map Default			
no data	Map Default	Map Default	Map Default	Map Default	Map Default	Map Default

Incidents Exceptions	Fastline PCD	HP200LX PCD	In-vehicle Device	Cable Television	Interactive Television	Internet
Incident	!	!	!		1	!
Construction/ Maintenance	!	!	!		1	!

Taking these factors into consideration, the TIS formed the group of ISP "teams" that would provide the applications and hardware for each technology component area. The teams and their technologies are listed below:

- PCD - FastlineTraffic. Provided Strider application operating on Motorola Envoy, using ARDIS packet radio network.

- **PCD - Peachtree Team.** Composed of ETAK, Hewlett Packard, SanDisk, and SkyTel, using the HP2OOLX palmtop computer, a SanDisk 20mb flash disk, and the SkyTel two-way pager.

- **In-Vehicle Navigation - Siemens.** Provided Siemens in-vehicle navigation unit, operating the Zexel USA software, using Navigation Technologies map database and incorporating FM-subcarrier communications provided by Differential Corrections, Inc.

- **Cable Television - ETAK.** Provided ETAK software and hardware integration to produce the computerized cable television programming, which was distributed using GDOT fiber optic connections and Georgia Public Televisions satellite distribution.

- **Interactive Television - ETAK/Source Media.** Provided an interactive television application which was installed at the Crowne Plaza Ravinia hotel in the Atlanta area.

- **Internet - Maxwell Technologies.** Developed the software application to operate the TIS Web site (www.georgia-traveler.com).

Figure 29 shows the teams selected to develop the applications.

Each of the applications is described in detail in the following sections.

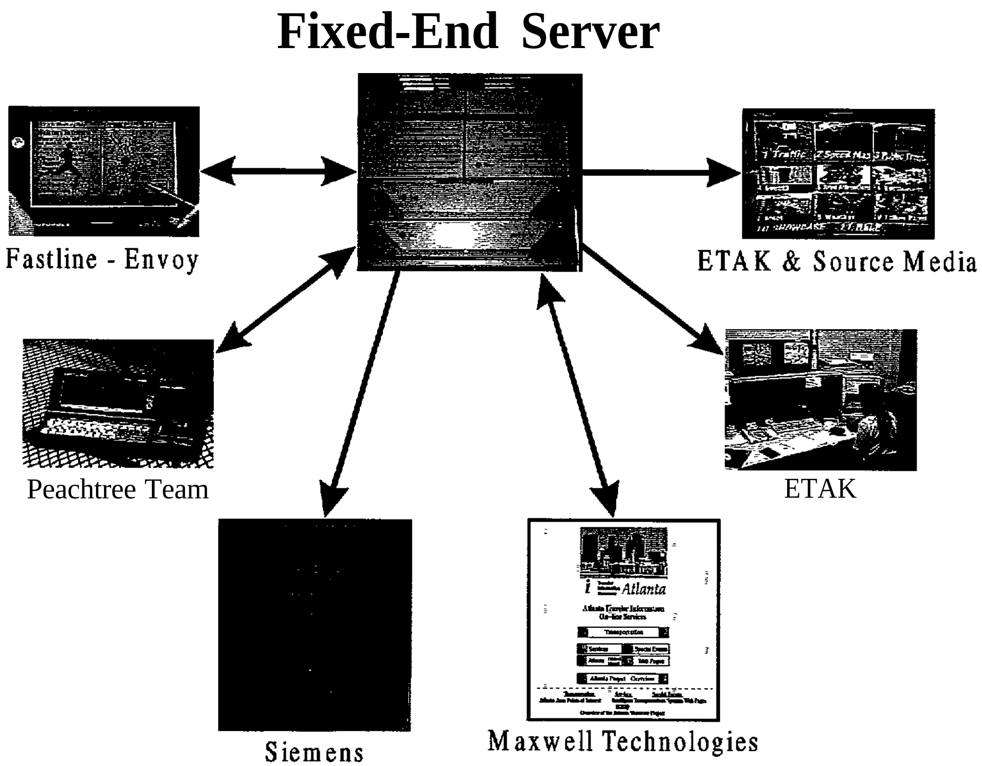


Figure 29. The Showcase formed ISP teams that provided the applications and hardware for each technology area.

Personal Communication Device

Personal Communication Devices

As part of the demonstration of technology during the Showcase, the personal communication device (PCD) was included to show the capability of personal services. This section describes the information distribution subsystem of the personal communications devices (PCDs), which are handheld computers. The key Intelligent Transportation Systems functions of this device included current congestion and incident reports, route planning, transit schedules and itinerary planning, electronic yellow pages services, and general information services, such as news, weather, and sports.

OBJECTIVE

The PCD subsystem was designed to provide travelers with a handheld device that could be carried anywhere in the Atlanta area and supply traveler information quickly and conveniently. The feature that distinguished this subsystem from the others was the use of an untethered, hand-held computer that provided interactive sessions between a user and the Showcase's fixed-end server (FES). The users would be able to roam freely throughout the Atlanta area and get current information over wireless communication links. The information was to be graphically displayed using standard transportation-related icons and maps as well as text and tables. The information services available included the following:

- **Congestion and incident reports.** All congestion and incident reports were sent to a PCD in response to a user request for current information. Congestion was reported in three ways: a solid square icon signified 0 to 30 mph traffic flow, an open square signified 31 to 50 mph traffic flow, and no icon signified free flow. Incidents were reported by triangular icons containing an exclamation point (!) placed on maps. When touched or tabbed-to, a text description of the situation was provided. Figure 30 shows icons used in the PCD displays.

- **Traffic route plans.** The user requested a route plan by specifying an origin and a destination. These points were specified either as a point-of-interest or a street address. Turn-by-turn directions were built and sent to the PCD, and the routes were displayed in two forms: a list of turns or a series of icons placed at turn points on the map (see Figure 31).

- **The Point of Interest (POI)** directory. The POI directory contained over 20,000 references to a wide range of places in Atlanta. Upon request by the user, a set of points meeting the user's search criteria was described by icon(s) that were overlaid on the map. Additional information, such as name, address and telephone number, also was available.

- **Wide area travel information for inter-city bus, train and air travel.** The location of each terminal was given, along with telephone numbers, and a summary of local hours of operation.

APPROACH

The highest area of concern for the PCD aspect of the demonstration was the development of software for the PCDs Central to the technical approach was the reduction of risk through redundancy: conduct two parallel and technologically independent development efforts. This strategy increased the probability that at least one PCD would be ready on time.

Architecturally, the heart of the system was the fixed-end server (FES), which collected, stored, and disseminated data (see Figure 32). In the client-server architecture of the TIS system, the PCD was the client. The FES collected data from the newly modernized ATMS, MARTA, CCT, and commercial sources, which described current activity on the Atlanta roadways and transit systems. The PCDs were composed of three basic technologies: handheld computers, wireless communications, and electronic maps:

- The PCDs were handheld computers equipped with wireless communications capability that supported interactive dialogues with the user. They provided a suite of traveler information services that advised users of congestion and incidents, planned routes, located points of interest, and reported general news. The partitioning of functions between the two was different in each of the two PCDs developed, due to differences in underlying technology as well as the technical approaches taken by the two teams.

- The FES provided current traveler information over wireless networks to the PCDs. The wireless networks were required to be two-way-capable of sending and receiving-which enabled interactive sessions in which the users could make requests that required services from the FES.

- The PCDs contained static maps of the Atlanta area. Icons which showed traveler information on the maps represented dynamic data on incidents, congestion, routes, and points of interest. The FES described these data as codes located at latitude-longitude coordinates. The PCD clients translated the codes into visual symbols (icons) and placed them on the maps using a coordinate scheme.

Alternatives Considered

The handheld computer industry divides itself into two broad categories, generally known as the vertical market and the horizontal market. The vertical market, which incorporates specific applications software to perform certain tasks, has been successful in niche markets for route delivery, gas and electric utility field staff, outside sales, and other related areas. These handheld computers use little or no general-purpose software. The horizontal market incorporates only general-purpose software packages such as personal calendars and telephone lists. This sector of the industry has struggled financially. The most successful horizontal products have been low-end systems, but they have no wireless capability. High-end systems have been only marginally successful. The Showcase invited several vertical market manufacturers to bid for the Showcase role, but none accepted.

The team conducted a feasibility study from December 1994 to January 1995 to discover commercial products that were suitable for the project. The conclusion drawn was that there were several hardware products that could be used but virtually no software (other than operating systems) that could be used. The traveler information application software would have to be developed during the project.

The TIS team then contacted the hardware and software organizations with experience in relevant areas and requested that they form teams composed of equipment manufacturers, software developers, and wireless network providers. The Showcase team prepared a requirements definition that was distributed to all interested parties, and the PCD teams were asked to present a one-day technical approach of their proposed system in Atlanta.

Alternatives Selected

Six teams responded to our invitation to form teams and make a presentation. Five actually made presentations:

- Xetron and BellSouth
- Fastline, Motorola, and ARDIS
- Loral, Apple, and ARDIS
- Maxwell Technologies, Apple, and RAM Mobile Data
- Psion, Holos Software, and RAM Mobile Data.

Each technical approach presentation was scored and ranked, and the selection was based on this evaluation. We added a wireless communications consultant to the staff to prepare questions for the wireless network providers and to help us assess their responses. We examined prior experience in software for the proposed PCD, wireless communications, digital map processing, and transportation systems.

In keeping with our risk-abatement strategy of selecting two parallel PCD efforts, we chose the team of Fastline, Motorola, and ARDIS, and the Xetron and BellSouth team (BellSouth provided both the hand-held computer and the wireless network).

In May 1995, Xetron notified us that production of the Simon (the proposed PCD) was about to end and the manufacturer (lBM) had no plans to produce a compatible successor. We informed U.S. DOT and were directed to issue a stop work order to Xetron. The Showcase did not want to include a PCD that was no longer manufactured. Immediately after the stop work order we re-examined the technical approach presentations with an eye to selecting the next most qualified candidate. At this time Hewlett Packard approached U.S. DOT and indicated strong interest in the project. They proposed a consortium led by ETAK that featured the HP2OOLX as the PCD and SkyTel two-way paging as the wireless network. They were willing to invest heavily in the project and meet the Showcase requirements for function and schedule. We were directed by U.S. DOT to evaluate the HP proposal, and the Showcase project team and U.S. DOT decided to select the ETAK-led team..

IMPLEMENTATlON

Implementation began immediately after the selection of Fastline and Xetron. An enhanced version of the requirements definition was published, and the teams were directed to produce a design specification that matched the requirements. In a parallel effort, both teams and the TRW staff began an effort to produce an interface specification that defined the interface between the PCDs and the FES. A three-day Interface Definition Workshop was held in Atlanta in April 1995. The resulting document, the Interface Control Document (ICD), specified the media, protocols, and data formats of the interfaces between the PCDs and the FES. The ICD originally described a single-interface standard for the Envoy and the Simon. After effort on the Simon was halted and the HP2OOLX was brought in, the interface specification expanded to two ICDs: one for the Envoy and one for the HP2OOLX. The interface for the Envoy was a custom interface designed for the Showcase. The interface for the

HP2OOLX was an implementation of TRW's landline distribution system (LDS) interface. The LDS was developed for earlier projects and re-used for this effort. Design control for the ICD was assigned to TRW and they published all versions. Fastline, Xetron, and the ETAK/HP team contributed to the design and were primary reviewers.

Envoy

The Envoy is larger than a palm-top computer and smaller than a laptop computer. It has a 3.25" x 4.25" screen, a Motorola processor, and 1 megabyte of RAM. The Envoy also has ROM for packaged software, such as a calendar; two PCMCIA type II ports; an infra red (IR) port; a serial port; and a built-in ARDIS wireless network interface. One PCMCIA port is used for a 2 megabyte SRAM card. Strider, the application system developed by Fastline for the Motorola Envoy, was stored on the card.

The Envoy ran General Magic's "Magic Cap" operating system (OS), an object-oriented OS in which all system objects are represented by icons and manipulated by touching the screen. Magic Cap is also a multi-media system in which icons may be animated and have sounds associated with them. Magic Cap was developed specifically for handheld computers that use a touch screen rather than a keyboard. Figure 33 shows the Envoy Screen.

Strider was completely contained on one 2-megabyte PCMCIA type II SRAM card. As Figure 33 shows, it is seen as both a building on Main Street and a traffic helicopter that flies above Main Street. True to its visual orientation, this Magic Cap application is launched by touching either the building or the helicopter. The use of an animated icon spotlights the application of computer technology to ATIS. Figure 34 shows the Strider main menu.

Strider featured bit-mapped graphic maps of the Atlanta area. The three levels of zoom implemented-an overview and two street-level maps-were based on Navtech digital maps. Bit-mapped graphic maps permit excellent pan but very limited zoom. The most noticeable feature of Strider was the smooth scrolling of maps. By touching the screen a user could see a smooth rolling image over the entire map coverage area. The maps also provided good quality icons for congestion, incidents, routes, and points of interest. In general, Strider functions were implemented as buttons and other visual devices that were touched to be invoked. Figure 35 shows a sample map.

Strider used the nationwide ARDIS packet radio wireless network to communicate with the FES. Most metropolitan areas are covered completely, but coverage lags in suburban and rural areas. For the Showcase, Envoy's users had good coverage, with some communication difficulties in the interior of large buildings, underground parking lots, and MARTA tunnels. In general, wireless communication was effective. Wireless communications functions were invoked when the users requested an information service such as a congestion and incident report. Strider formed request packets and sent them to the FES via ARDIS.

Wireless communications are expensive. In the first operational version of Strider it cost about $5.00 to get a congestion and incident report. Subsequent optimization brought that cost down to about $.30. There are additional optimizing measures that could be taken to bring the costs down under $.20. The consensus on the project was that it should cost about what a phone call costs to get traffic information. Strider is in the ballpark.

The reliability of the ARDIS network was good. We had no cases of use failure because the network did not work. Response time and throughput were adequate. Given the relatively slow speed of the

Figure 35. Strider features bit-mapped graphic maps of the Atlanta area.

network it is unreasonable to expect sub-second responses. Also, packet networks are not designed for interactive work. Response times fell within the 15 second to 2 minute range, which was judged to be adequate.

Strider had excellent ease of use. The application launched straightforwardly; functions were selected by touching icons; the behavior was predictable and clear; and navigation was simple (see Figure 36). Wireless communications functions were not explicitly requested. When the users requested a traffic update, Strider would build the packets and send the request without direct intervention from the user. The user was obliged to turn on the radio, which is due to an FCC regulation which prohibits turning such radios on under computer control.

HPZOOLX

The Personal Travel Guide (PTG) application was developed by the ETAK and Hewlett Packard (Peachtree) Team, which is a consortium of HP, ETAK, SkyTel, and SanDisk. HP provided the 200LX palm-top computers and the applications design. ETAK provided the software development staff for the 200LX code and the Traffic Workstation used to provide selected functions and interface the PCDs to the FES through the SkyTel network.

The HP2OOLX is a palm-sized DOS system. It has an Intel 286 processor and 530 kilobytes of RAM. It also has ROM (for packaged software such as Quicken), a PCMCIA type II slot, an infrared port, and a serial port. The PCMCIA slot is occupied by a 20 megabyte flash RAM card devoted to PTG. The serial port is used to connect to the pager for wireless communications (see Figure 37). The HP2OOLX palm-top computer runs DOS 5.0 and features a full keyboard. It is Windows-like in that it has an icon screen in which applications are shown as icons. To launch an application, the user tabs to an icon and presses ENTER (see Figure 38).

Figure 38. The HP200LX runs DOS 5.0 and uses icons to display applications.

PTG, contained in RAM and on the PCMCIA card, was seen as an icon on the OS icon screen. PTG was launched by moving the light bar (tab or arrow keys) to the icon and pressing ENTER. PTG is a map-centric application-all information services are seen as attributes of the map. The maps are vector maps based on ETAK digital maps. Vector maps offer great detail and virtually unlimited zoom capability. A key feature to these maps was that unnecessary detail was removed at overview levels and inserted as the user zoomed in. A wealth of details, such as street names, appeared when appropriate. A key weakness was that they were slow to pan. Lateral movement across a map view was annoyingly slow. Many users zoomed out, then panned laterally, and then zoomed back in. Navigation over map views was done with arrow keys. This was a natural user interface function that worked very well.

In general, PTG functions were implemented as softkeys, which are special uses of function keys. PTG built a set of key labels across the bottom of all screens that assigned PTG functions (such as zoom in and zoom out) to function keys. The applications showed a surprising level of refinement in this area given the tight budget and schedule. Most user functions could be launched in several ways, giving the users a range of personal preference options that went quite beyond the original functional requirements.

As described earlier, PTG used the SkyTel two-way pager to communicate with the FES. To get a traffic update, the user cabled the 200LX to the pager and touched the update softkey. PTG then formatted the request as a message and sent it to the pager. PTG notified the user when the message had been sent. The pager sent the message via the Skytel paging network to the ETAK Traffic Workstation (TWS) located in the TMC. The TWS would reply with data it had acquired from the FES. The link between the TWS and the FES operated in “firehose” mode-there was a continuous “spraying” of current congestion and incident data from the FES to the TWS.

PTG took advantage of the considerable storage capacity of the 20 megabyte PCMCIA card to hold more data locally. This significantly reduced its dependence on the wireless network, speeded up responses, and lowered communications costs.

Response time was an issue with the SkyTel network. Response times were long, some times 30 seconds or so, sometimes greater than 10 minutes. The SkyTel network is even less well suited to interactive uses than ARDIS. Its main virtues are that it is a technology familiar to users and widely available. However, coverage was an issue-one PCD user returned the device because he could not get service where he lived. SkyTel offered us a fixed-price arrangement for the Showcase. We did not examine costs on a per-message basis, so no conclusions can be drawn with respect to value or legacy costs to commercial users. It is reasonable to assume that similar constraints apply to SkyTel as ARDIS because both charge on the basis of messages and characters. Little emphasis was placed on optimizing wireless traffic because of the fixed-price arrangement with SkyTel.

Ease of use also presented some concerns. While PTG was well designed and the DOS/Windows-like user interface was familiar to users, the connection to SkyTel was awkward. HP provided excellent user documentation that eased the burden considerably. A serious commercial product must integrate the communications and the computer.

Table 11 compares the Motorola Envoy and the HP2OOLX.

Table 11. The Two PCDs Had Distinct Capabilities

CAPABILITY	ENVOY (BIT-MAPPED MAPS)	HP200LX (VECTOR MAPS)
Zoom Capability	3 Discrete Levels	Virtually Unlimited
Map Base	Navigation Technologies	ETAK
Panning	Smooth, Easy	Slow, Jerky
Map Detail	Limited, Static	Unlimited, Dynamic
Navigation	Touch Screen with Stylus	Keyboard
Storage	Remote on FES	Locally PCMIA and Hard Disk
Coverage Response Time	Adequate, 15-30 Sec	Spotty, 30sec-10 min

LESSONS LEARNED

- **The compressed schedule and mandatory delivery date placed tremendous stress on the already high-risk PCD effort.** The two-PCD approach, devised as a risk mitigation strategy, was the right choice for reducing the risk of not having a PCD available during the demonstration period. Both PCD subsystems (a total of 1.3 million of software) were delivered on time (16 months) and within budget.

- **The selection of PCD teams turned mostly on the technical approach taken.** Once the PCD teams were chosen, the Showcase project team did not direct their work. As a result, we did not see several important issues until late in the project (e.g., the disconnection between Solaris and SunOS).

- **Global Positioning System (GPS) technology was originally considered and found not to be feasible for this project.** It was expensive, awkward, power hungry, and marginally useful. GPS technology has improved tremendously in the past few years, and should be reconsidered as an option in future applications.

- **More emphasis must be given to optimizing wireless communications.** Subsequent efforts should pursue bit encoding, data compression, and packing multiple requests into single packets.

- **More emphasis should be placed on memory management-the critical technical resource-in the development of the PCD software.**

In-Vehicle Devices

In-Vehicle Devices

The in-vehicle device was one of the technologies selected to demonstrate the application of Advanced Traveler Information Systems (ATIS) for the Traveler Information Showcase. The team members for the in-vehicle demonstration included Siemens, which provided the in-vehicle computer and visual display unit; Differential Corrections Inc., which provided the radio receiver and antenna, and delivered real-time traffic information to the vehicles; Navigation Technologies, which supplied the digitized map database, electronic yellow pages, and point of interest database; Zexel USA, which developed the software; and Oldsmobile, BMW, and Hertz, which provided the automobiles.

OBJECTIVE

The objective of the in-vehicle device demonstration was to distribute real-time traffic information to travelers in their vehicles in the metropolitan Atlanta region during the Showcase period (June 1 through September 30). The devices were installed in 96 automobiles, including 30 Oldsmobiles which were part of the official General Motors Olympic fleet.

APPROACH

As with the other technology areas, the approach used for the in-vehicle application was designed to minimize the amount of custom software development needed. Therefore, emphasis was placed on systems with established route guidance capabilities. To their existing functionality was added the ability to receive real-time traffic information and display it to the driver.

Siemens Automotive was selected to provide the in-vehicle application. The Siemens team consisted of Siemens hardware, Zexel navigation software, Navigation Technologies map database, and Differential Corrections Incorporated's FM subcarrier technology. The Showcase team selected the Siemens unit because of its simplicity of use and its inherent capabilities of route guidance. The Showcase enhanced this commercial product by developing the capability of receiving real-time traffic and road conditions. The approach used to achieve this followed three steps:

- **Data Integration and** Processing. The fixed-end server (FES) located at the Transportation Management Center (TMC) was the data feed for the navigation system. Once the data were collected, the FES processed it into the right format and sent it out.

- **Data Dissemination/Communication.** The information from the FES went through an FM subcarrier, which frame relayed the data through satellites. The data were transmitted through standard FM radio stations on a separate frequency.

- **Data Display.** The data were received in the automobile through an FM antenna, and a receiver stripped the data messages to display traffic information on the unit's display. The device software matched the respective location of the received traffic information to the map and displayed icons on speed, incidents, and other traffic information.

Figure 39 illustrates the TIS in-vehicle device architecture.

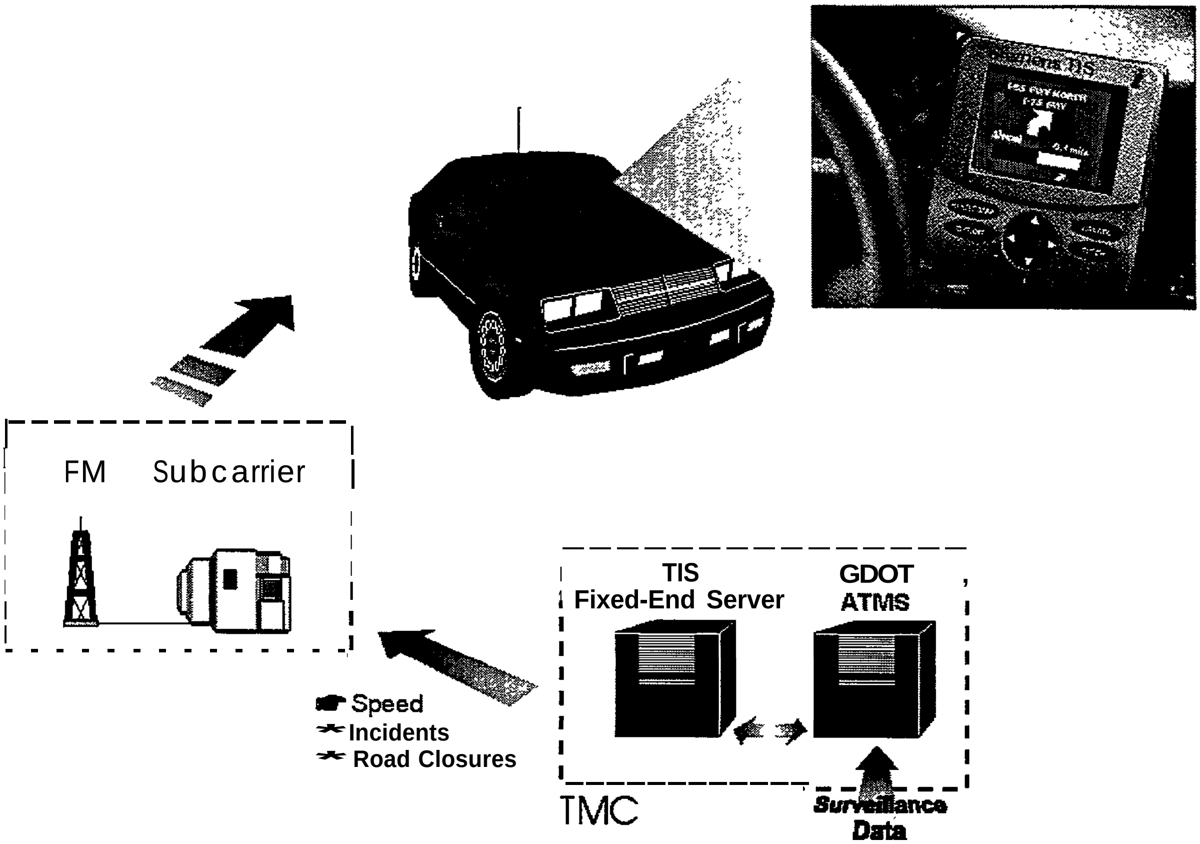


Figure 39. The FES processed the data and sent it to the FM subcarrier, which then transmitted it to the DCI receiver in the vehicle.

Alternatives Considered

The overall goal of the Showcase use of in-vehicle technology was to have a navigation device which was capable of receiving real-time traffic information and displaying it to users so they could make better travel decisions. To achieve this goal, the Showcase conducted a vendor selection process to identify a system out of the available "off-the-shelf' navigation systems in the market. The vendor selection criteria was focused on basic functionality of the device; ability to develop, integrate, and display real-time traffic information in a short time frame; and cost of the system.

The vendor selection process began in the first quarter of 1995. The Showcase project team approached several companies to gather information about their products: Sony (NVXF160 Mobile navigation system), DELCO (Telepath 100), Siemens (Tetrastar), Amerigon (AudioNav), and Nippondenso (Navigation system). Most of these companies provided a "hands-on" demonstration of their product.

Functionality criteria that were considered included route guidance capability, map and point of interest/yellow page database, location on a map, distance to destination, directional arrow, text description, Global Positioning System (GPS) function, and the ability to display traffic information. Based on these functions, the selection was narrowed to the Siemens Tetrastar system or Sony NVXF160 system. A critical factor for the selection was the communication between the Showcase FES and the navigation system. The communication approach had to be cost-effective, reliable, and fast. Different types of communication technology, such as high-speed FM subcarrier and cellular, were investigated to determine their interface with the navigation system.

Alternatives Selected

The Siemens Tetrastar was chosen as the navigation device for the Showcase (Figure 40). The Siemens team included communications provider DCI and software developer Zexel, USA. The system was chosen for the following inherent functions and the capability to enhance the existing system to receive real-time traffic information:

- **Map Database.** The database selected was an extended Georgia/Florida map database. The database extension included a detailed city specification for the five-county metropolitan area surrounding Atlanta. The database included Olympic-specific data on event locations and event park & ride lots, detailed information on MARTA transit stations, and a comprehensive listing of local restaurants, hospitals, tourist attractions, emergency services, and other points of interest to travelers. Most of the listings had a telephone number along with the address and distance from origin.

- **Route Guidance.** The route guidance functionality was one of the main functions considered in using the above unit. The unit always knew the origin of the vehicle by using GPS. It requested an input of destination by providing the driver with various choices. The calculation of the route was then based on several criteria that the user had to enter. The unit also allowed the capability of selecting alternate routes if a user "missed a maneuver" or wished to "cancel the current guidance." The additional feature of the route guidance was the unit's capability to provide voice prompts as the driver navigated. More detail on the route guidance functionality is described in the *Functional Definition Document*, Version 5.0, Chapter 5.0.

Figure 40. The Showcase project team selected the Siemens in-vehicle device for the demonstration.

▪ **Display of Traffic Information**. The unit was to display traffic information in a form that was easy for the driver to comprehend. Different options of displaying the traffic information were considered in the beginning, such as textual descriptions, voice prompts, and colored icons. The decision was made through an integration effort to standardize icons for all ITS Atlanta systems, so that all information was displayed in the form of icons of different shapes and colors. Although this was not the best form for the navigation system, the problem was resolved by modifying the icons to tit the display screen (Figure 41).

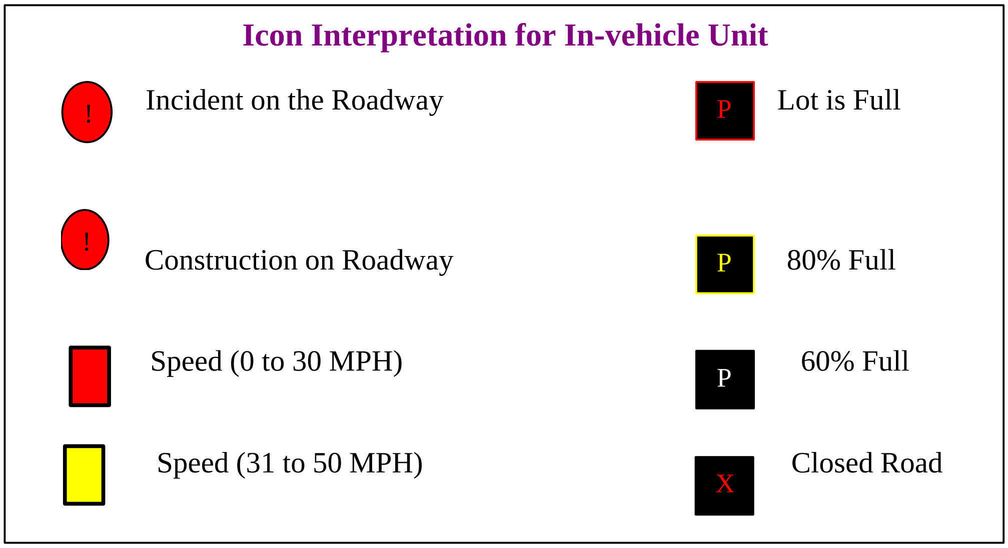


Figure 41. The in-vehicle device displayed navigation information with icons of different sizes and shapes.

The unit had two modes, the "map mode" and the "maneuver mode," and the traffic information was displayed on the map mode so the user could more easily comprehend the area where the traffic problems were located. If the user was in the maneuver mode, the unit provided an indication that traffic information was available and the user had the capability to switch to the map mode to view the traffic conditions. The one exception to this was that the information that was being displayed would be "all the information received" at that particular time. The alternative of providing information only on the route that the user chose was technically feasible but not done because of the limited time and resources for software development.

▪ **Communication.** The communication method provided by DCI was the FM subcarrier technology, which allowed the interface between the FES and the unit. The technology provided a coverage of approximately 100 miles around Atlanta based on the number and location of radio stations that were contracted for the Showcase. The hardware required in the vehicle to receive information through this method was a DCI receiver in the trunk and an FM antenna. Unlike the PCD application, the in-vehicle device was not an interactive system with the FES. The traffic information was broadcast (one-way) from the FES over the FM radio signal to the unit in the car.

IMPLEMENTATION

The first step in implementing the in-vehicle subsystem of the Showcase was to define the additional functionality required of the in-vehicle device. Through a series of team meetings and discussions among Battelle, TRW (FES), Siemens, Zexel (Software) and DCI, this added functionality was documented and included in the Functional Requirements Document. Then, as described earlier, a detailed Interface Control Document (ICD) was developed which defined the exact messages and their formats which were to be passed from the FES ultimately to the in-vehicle unit.

The critical part of the system design was the construction of the location table. This table cross referenced the Navtech extended database to all the exit and entrance ramps on the Atlanta freeway and arterial system. The location table was loaded onto the hard drive in the in-vehicle unit (which contained the software for the unit) and the FES. This location allowed the FES to send relatively small "coded" messages which told the in-vehicle unit where to place what icons. Using this table, information on travel speeds, incident/accidents, road construction, road closure, and Olympic Games park & ride status could be broadcast directly to the vehicle and displayed for the driver. ACOG did not finalize their list of park & ride lot locations until days before the Olympic Games began. However, because of the logistics associated with producing 100 hard-disks with the software and database "burned" into them, and then installing these units in vehicles, changes to the in-vehicle units database were frozen on April 1, 1996. Unfortunately, this meant the list of park & ride lots in the vehicles did not match the actual lot locations set up by ACOG. This problem was remedied by providing a laminated sheet of paper with each unit that listed the latest updates of the addresses of the park & ride lots.

DCI contracted with six radio stations in Georgia to provide the required coverage of approximately a 100-mile radius around Atlanta. The six stations were WRFG-Atlanta, WSKZ-Chattanooga, WSTH-Columbus, WJTG-Macon, WEAS-Savannah, and WRAF-Toccoa. Figure 42 illustrates the DCI coverage area for the Showcase.

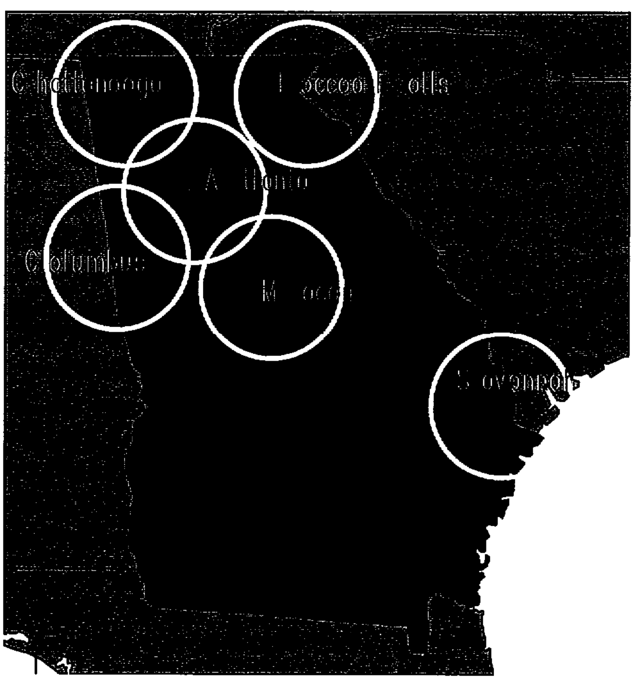


Figure 42. The FM subcarrier technology provided a coverage of approximately 100 miles around Atlanta.

The real-time traffic information that the navigation unit displayed was data on speed, incidents, construction and maintenance, road closures, and Olympic park & ride lots and their capacities. The icon shapes and colors were designed to be as consistent as possible with the overall ITS Atlanta concept.

Users of the in-vehicle unit could select to use either the map mode or the maneuver mode. Figure 43 shows an example of both the maneuver and the map mode. The map mode showed a map of the roadway system in the area of the car-the user could select scales where an inch on the screen equals l/8, l/4, 1, 4, or 16 miles on the map-with a triangle representing where the vehicle is located. It was only in the map mode that users could see the real-time traffic icons. The maneuver mode simply displayed for the driver what the next maneuver (a turn) would be. On the map, speed information was presented in two ranges: 0 to 30 mph (red squares), and 30 to 50 mph (yellow squares). The device did not display speed icons for ranges 50 mph and above because of the limitation in the number of messages and the number of icons shown on the map at a given time. The incidents were represented with red circles with a black exclamation mark inside, and road maintenance/ construction was shown as a yellow circle with black exclamation marks. Capacities of Olympic park & ride lots also were indicated: red ‘Y-100 percent full; yellow "P-80 percent full; and white "P"-60 percent full. Although the system was designed to receive park & ride lot data, this information was displayed for only a few days because the information collected by the Atlanta Committee for Olympic Games was sporadic and unpredictable.

Road closure information was displayed with a red “X” over the closed road segment. While the system could place a red X where roads were closed, this was not incorporated into the route calculation algorithm. Sufficient time and funding were not available to include this type of dynamic route calculation. Similarly, the system did not automatically route drivers around accidents or congested areas. All re-routing was left up to the vehicle operator. The map mode also had a ‘“IT’ icon at the bottom of the screen which changed colors: green when real-time traffic data were received, and red when the data were not received. This color code was used as an indication during testing but was left in the design because it was a good identification when the station signal strength was not strong enough to receive the traffic information.

On the maneuver mode, the indication that real-time traffic information was received by the unit was achieved by displaying a message string “Traffic Information Available” when data were received. This allowed the user to switch to the map mode and view the current traffic information.

The Showcase had 100 of the Siemens units for the four-month period of June 1 to September 30. In general, the units were placed in the Olympic fleet (30 Oldsmobiles), in Hertz vehicles (20 rental cars), in BMWs (5 demo/test cars), and in various businesses organizations throughout Atlanta that fit the user profiles described later. A comprehensive discussion of user identification and selection and distribution of the devices is provided in the Technology Distribution and User Assessment section of this report.

The installation of the units took longer than expected because of the schedule and variety of automobiles. Specific hardware (wiring harness) was required for different vehicle types (e.g., GM, Ford, Vans, and Sports Utility) and had to be custom made to allow the complete system installation. This diversity of users had an impact on getting all of the 100 units installed by June 1,1996. The average time required to install one unit was approximately one day, based on the type of vehicle.

Once the units were installed, they were tested before returning the vehicles to the users. The users also were trained prior to the installation of the units. A brief instruction sheet was provided which described the functions of the system and represented the traffic information in color. The users also were given a one-page survey questionnaire, and the surveys were collected periodically during the Showcase.

A “hotline” number provided customer service for 16 hours a day during the Showcase operational period. The units occasionally had problems with the software needing “a reboot” or “getting lost.” A Siemens technician was available during Showcase operating hours to fix any problems. No major problems occurred during the Showcase demonstration period.

LESSONS LEARNED

The Showcase successfully integrated the in-vehicle subsystem and display of real-time traffic information to a navigation device. Several lessons were learned during the project.

- **The icons used for in-vehicle display need to be carefully developed.** The device displayed icons for speeds, incidents, and other traffic-related information. The major flaw in the design-realized once the development work had been completed-was that the user cannot easily interpret the "direction of the icon" (e.g., on the northbound or southbound lane). The user could zoom to the lowest level and see the direction, but the traffic information on this level was not always available, and when it was available (or viewable) the driver was often "on top" of the accident or congestion, defeating the purpose of notification. The system allowed the user to zoom-in to a greater level of detail only around where the vehicle was located. The user could not zoom in to the planned route or elsewhere on the map, and therefore was unable to get the directional information associated with the traffic icon. Alternatives need to be considered to solve this issue. One design alternative that was considered was providing traffic information only on the route selected, which would have avoided the confusion, but because of the project's time limitations, this was not accomplished. Another alternative is to provide different colors for different directions, or provide a directional index next to the icon.

  Road closure icons were another area where the design and implementation needs to be improved. Placing a red "X" over closed roads is an easy way to show a driver that a road (or exit ramp) is closed. However, due to the size of the icon and the overwhelming number of closures experienced during the Olympics (much of a 3-mile radius around downtown experienced significant traffic pattern changes), very few closures were broadcast to avoid the inevitable "screen clutter" that would result.

  Another visible problem was the icon size. Sometimes during rush hour traffic the screen would be clustered with so many icons that the user could not really interpret the actual locations. This also led to icons being placed on top of one another. This issue was raised during development but was dismissed because of the consistency requirements of other systems.

- **The area of coverage needs to be carefully determined.** The team realized that there were several dead spots where the PM station signal strength was not strong enough to receive the traffic information. There were dead spots in areas when the car would move from one area served by a certain station to another area served by a different station. While the implementation met the design constraint of broadcasting this information out to approximately a 100-mile radius around Atlanta, users indicated that the extended broadcast coverage was not that useful because most users did not travel with their systems more than 20 miles outside the Perimeter. In addition, even if they did travel further, all the real-time traffic information (with the exception of a few radar site locations) was focused around and inside the Perimeter.

- **Hardware needs to be installed so it is "thief proof."** During the Showcase period, the team had a significant number of parts stolen from the cars, mostly in the rental cars. Some parts of the hardware (e.g., PM antennae, hard drive) were easily accessible by opening the flap of the CPU or by pulling the wire off the antennae. It is important to secure this equipment in the car and also place the equipment in a location which is not easily accessible by the user.

On-Line Services

As part of the Traveler Information Showcase (TIS), a World Wide Web site was created to demonstrate how real-time traveler information can be viewed via the Internet. The Web site, www.georgia-traveler.com, highlights real-time traffic information, including travel speeds and incidents, as well as route guidance information.

OBJECTIVE

The objective of the on-line services demonstration was to provide Internet users with real-time traffic and public transportation information, route planning, and electronic yellow pages.

APPROACH

The approach to developing the on-line services for the TIS included determining where the Web server would be located, the type of communications systems to be used, the format and design of the actual pages on the Internet, and the types of information to be provided to users.

Alternatives Considered

The Web server acts as the center of activity during a request from a user on the Internet to the georgia-traveler Web site. A key task for establishing the Showcase's on-line services was to designate where the Web server should be located. One option was to place the Web server with the traffic software developer in California With the Web server in California, troubleshooting and changes could be easily executed by the developer. Another option was to locate the Web server at the Transportation Management Center (TMC) in Atlanta. With this option, the Web server would reside with all other equipment considered for legacy after the Showcase period. If placed at the TMC, the equipment would also be accessible to operations management 24 hours a day to ensure that the Web site was always working properly.

Communication was another area with different options to consider. First, a service provider, or "on-ramp" to the Internet, had to be established. Second, a type of communication line needed to be specified. Options for the communication line included either an entire T1 line or a fractional T1 . The size of the line would depend on the amount of potential traffic across the line to the Web server.

The location of the real-time traffic data and route guidance data posed another question: Where should these data reside-on the Web server or the fixed-end server (FES)? Two separate approaches were examined to resolve this question: central computing versus distributed computing. Central computing is used when all data needs to be located on one computer. In the case of the on-line services, all data would be located on the Web server. Distributed computing is used when data are to be located on more than one computer. With this scenario, the Web server would make a request from the FES for real-time traffic and route guidance queries.

When designing any Web site, a variety of options can be used for the layout and flow of the pages. When first designing the on-line services Web site, the following layout for the home page was established:

- Welcome screen and brief description of Intelligent Transportation Systems (ITS) and TIS programs
- Atlanta Real-Time Travel Information, including maps of real-time traffic speeds and incidents, route guidance queries, and a yellow page section (similar to a telephone book)
- A description and demonstration of all TIS technologies
- A listing of all TIS partners
- Access to TIS marketing and public relations materials
- A link to the Atlanta Committee on Olympic Games (ACOG) Olympic Web site.

During the initial planning of the route guidance for the Web site, the option for calculating a route guidance request using different modes of transportation was considered. These modes were automobile, public transit, or automobile and public transit combined. The public transit portion of the route request was to come from the link established between the FES and MARTA's PARIS system.

Alternatives Selected

The following alternatives were selected and implemented for the operational period and legacy of the on-line services section of the Showcase.

The Web server would remain at the TMC. During the operational period of the Showcase, the operations manager could troubleshoot any Web server problems at all hours. The Web server also would be accessible to GDOT for legacy operations. Using the Internet, the developer could still "dial-in" and access the Web server to perform routine maintenance and download software updates.

The Internet service provider selected for the on-line services was Peachnet. The Showcase also decided to utilize an entire Tl line to provide sufficient communications to accommodate for the potential large volume of Internet users during the Olympics. While no one could predict the amount of "traffic" or uses the Web server would receive, the entire Tl gave ample capacity and also provided the potential for GDOT to expand their Internet access from within the TMC.

The choice was also made to use distributed computing as a means to manage the real-time traffic data and route guidance queries. With this configuration, the Web server made requests to the FES for data not located on the Web server. This data includes the real-time traffic information (speed, incidents, road maintenance, and road closures) and the actual route planning queries.

Figure 44 shows the final design of the georgia-traveler home page. Each major section of the page is described below:

- **Transportation.** Because the real-time travel information was the main product being showcased for the project, this was also the focus of the home page. Under this heading the following information is available: Real-Time Traffic, Public Transit, MARTA Parking Information, Wide Area Travel, Route Guidance and a general Atlanta Freeway Map. Figure 45 shows a schematic of the information available under the Transportation section.

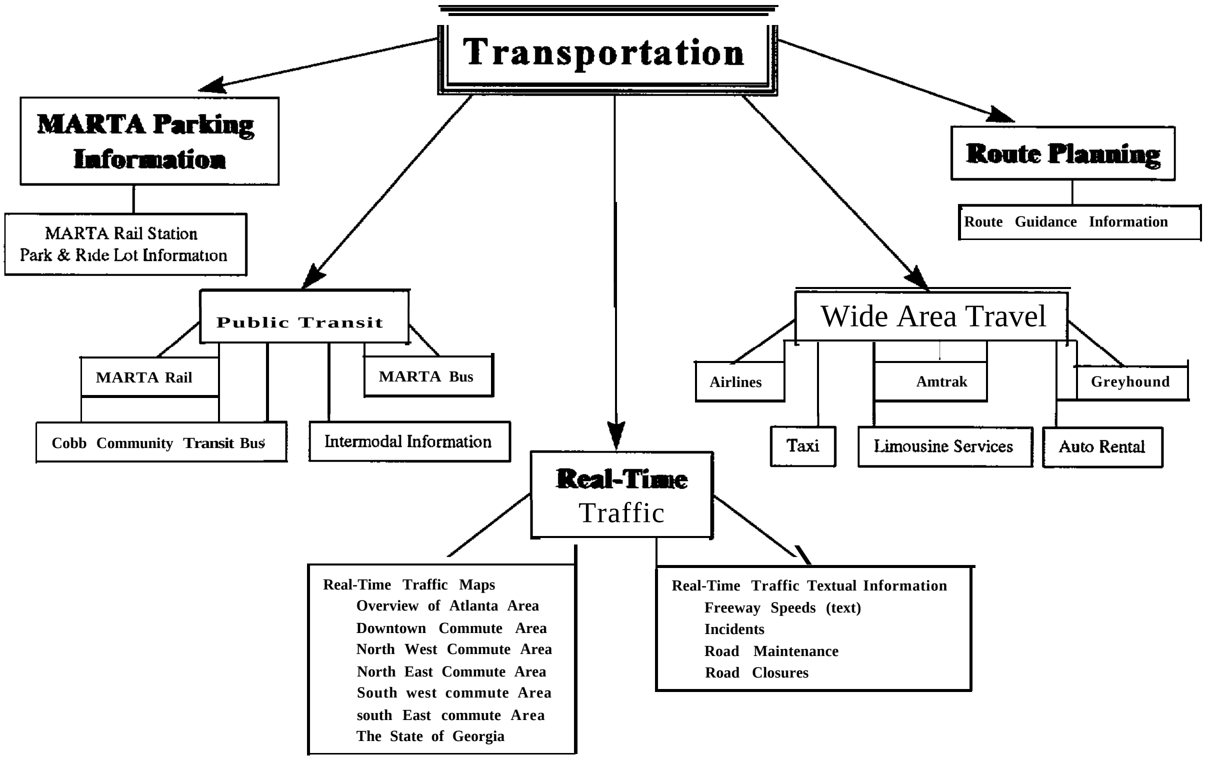


Figure 45. The Transportation section of the Georgia-Traveler home page offered a wide range of on-line information.

- **Services.** Under this heading, a user could access information concerning dining, lodging, movies, weather, and other Atlanta information services. When available, links to other Internet Web sites concerning Atlanta services were used.

- **Atlanta Points of Interest.** This area of the Web page focused on interesting sight-seeing locations such as museums and history and science centers. Again, when available, links were created to existing Web sites for Atlanta points of interest.

- **Special Events.** During the Olympics this section included links to the Olympics, Paralyrnpics and Olympic Arts Festival Web sites. Also included are links to Atlanta team sport pages, such as the Atlanta Braves.

- **ITS Web Pages.** The ITS section provided a direct link to the ITS Online World Wide Web page, where a plethora of ITS information is listed.

- **Atlanta Project Overview.** Users could find information on the Traveler Information Showcase. Items of interest included a description all of the technologies, information on partners and service providers, and Showcase newsletters.

IMPLEMENTATION

Communication was one of the key factors for the Showcase on-line services to succeed. This aspect of the project included the communication between the Web server and the FES and the Web server and the Internet (T1 line). Figure 46 shows the on-line services architecture. Communication between the Web server and FES, and the Web server and the Internet were essential Without this, users on the Internet could not access the georgia-traveler Web page. This communication between the Internet and Web server utilized an entire Tl line. The complete T1 line access provided sufficient capacity to handle the anticipated number of users accessing the georgia-traveler Web site.

For the real-time traffic and route request information Maxwell Technologies developed software to interact with the FES using a message-based session interface. The message-based session included specific message body structure and content for each type of information request made from the Web server and response returned from the FES. These request sessions were established using Unix Sockets protocols. The message-based session interface was designed to handle “packetized” message capabilities of wireless communications systems. Maxwell Technologies provided software which interfaced with this system, breaking each request into the appropriate “packets” and reconstructing the response “packets.”

For the real-time traffic, incidents, road maintenance, and road closures to appear on the georgia-traveler Web page, the Web server created a session with the FES and acquired the real-time data. Figure 47 depicts this process of the Web server receiving real-time traffic information from the FES. This updating process is a continual loop that takes approximately five minutes to complete, which provided the user with accurate traffic information no more than five minutes old. Figure 48 is an example of a real-time traffic map.

The route request portion of the Web site also required communication with the FES. The NavTech database of streets and points of interest was stored as static data resident on the Web server. Figure 49 shows the route request and calculation process using the Internet. The route request for selecting different modes of transportation was not fully implemented. The software has been written for the Web server and the FES portion of this process. However, at the time of publication the MARTA portion of itinerary planning was not available through the ATMS network. If that process becomes available in time, this option will be tested and then made available on the Internet. Figure 50 shows the data input screen for a route guidance request.

Under the main transportation heading on the home page, there is a section on public transit. For Atlanta, there are three main sources of public transit: MARTA Rail, MARTA Bus, and Cobb Community Transit (CCT). To implement access to information on MARTA Rail and Bus, links were established to the MARTA World Wide Web site. Copies of the CCT schedules and fare information were obtained and posted directly on the pages of the georgia-traveler Web page for easy access to users.

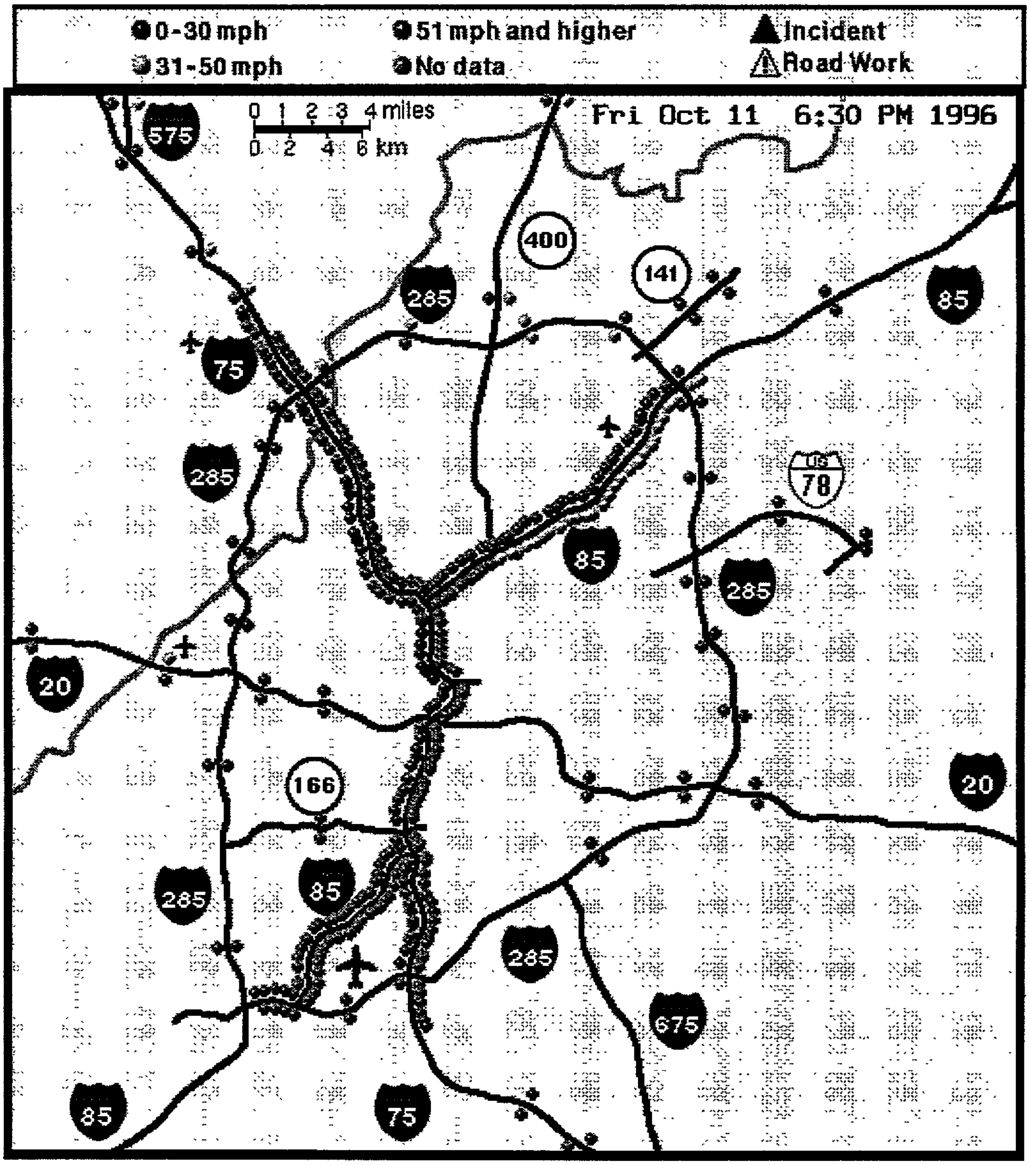


Figure 48. The Web site provided users with real-time traffic information.

LESSONS LEARNED

During the development of the Web site and operational period of the Showcase, a variety of lessons were learned about developing and implementing on-line services for traveler information:

- **Development is easier if the developer is on site.** During the development of the Web site, the subcontractor conducted their Web page and software development off site. However, the Showcase did not have an operational T1 line until just before the Web site was operational. The absence of the T1 line hampered development and testing of the georgia-traveler page because

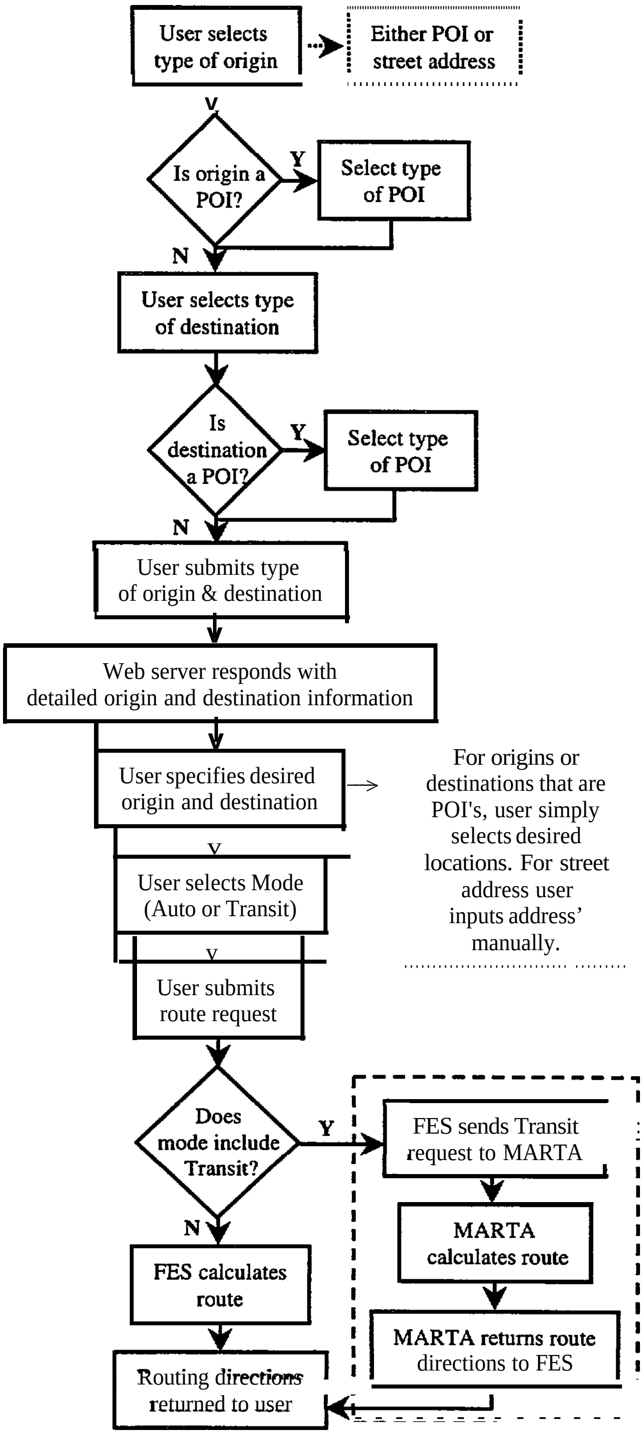
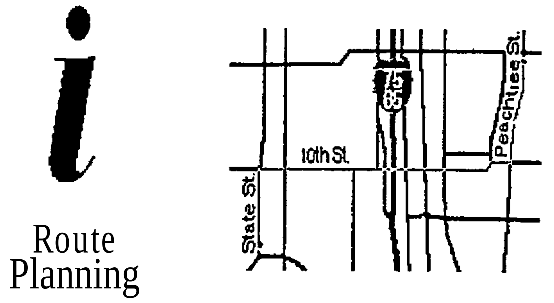


Figure 49. The Showcase implemented software for calculating route requests.

this was not conducted at the TMC. It would have been more efficient to have the subcontractor on site for their final development and testing of the Web page, given that the Tl line was not connected during this period.

When designing any Web site, especially one with a variety of graphics like the georgia-traveler site, it is important to keep the audience and their browser capabilities in mind. Internet users have a variety of browser programs for accessing the Internet. While designing the georgia-traveler Web page, it was necessary to design the Web site so that a browser with limited graphics capabilities could access a majority of our information. One solution for this issue was to make 'text' options available for tables and graphics.

- **One of the benefits of the Internet is the ability to create links to other Web sites.** This benefit was utilized in the design of several different sections of the georgia-traveler Web site. One lesson learned is to be aware of what Web sites are available or are in the process of being developed while creating the page. While designing the MARTA bus and rail sections, the on-line services subcontractor was tasked to create five of the most popular MARTA bus routes and a clickable rail map to be displayed on the Showcase Web site. After much time and money were spent creating these pages, MARTA decided to include all bus schedules and a clickable rail map on their Web page. The Showcase then decided to link to MARTA's new bus and rail pages, putting them in charge of updating their own schedule information. Although this ultimately benefitted the Showcase, time was misspent on duplicate efforts.



Atlanta Area On-line Routing Information

By entering either the address or the type of point-of-interest to and from which one wishes to travel in the proper areas of this form, the Atlanta traveler will be able to obtain precise routing directions and transit information.

Select the what type of information you would like to enter for the start and end points of your trip.

For example, if you would like to begin at an Atlanta point of interest, click"Atlanta Point of Interest" under "Origin Type" then select a category from the point of interest category list. If you know the exact address of the location where your trip begins, click "Street Address" under "Origin Type" and later you will be asked to enter the address.

Origin Type:

^ Street Address v Atlanta Point of Interest

If you've decided to start at a particular point of interest, select the category of interest point here:

Airport
Amusement Park
ATM
Auto Service & Maintenance
Automobile Club
Bank Facility

Figure 50. The Showcase Web site provided routing directions to users.

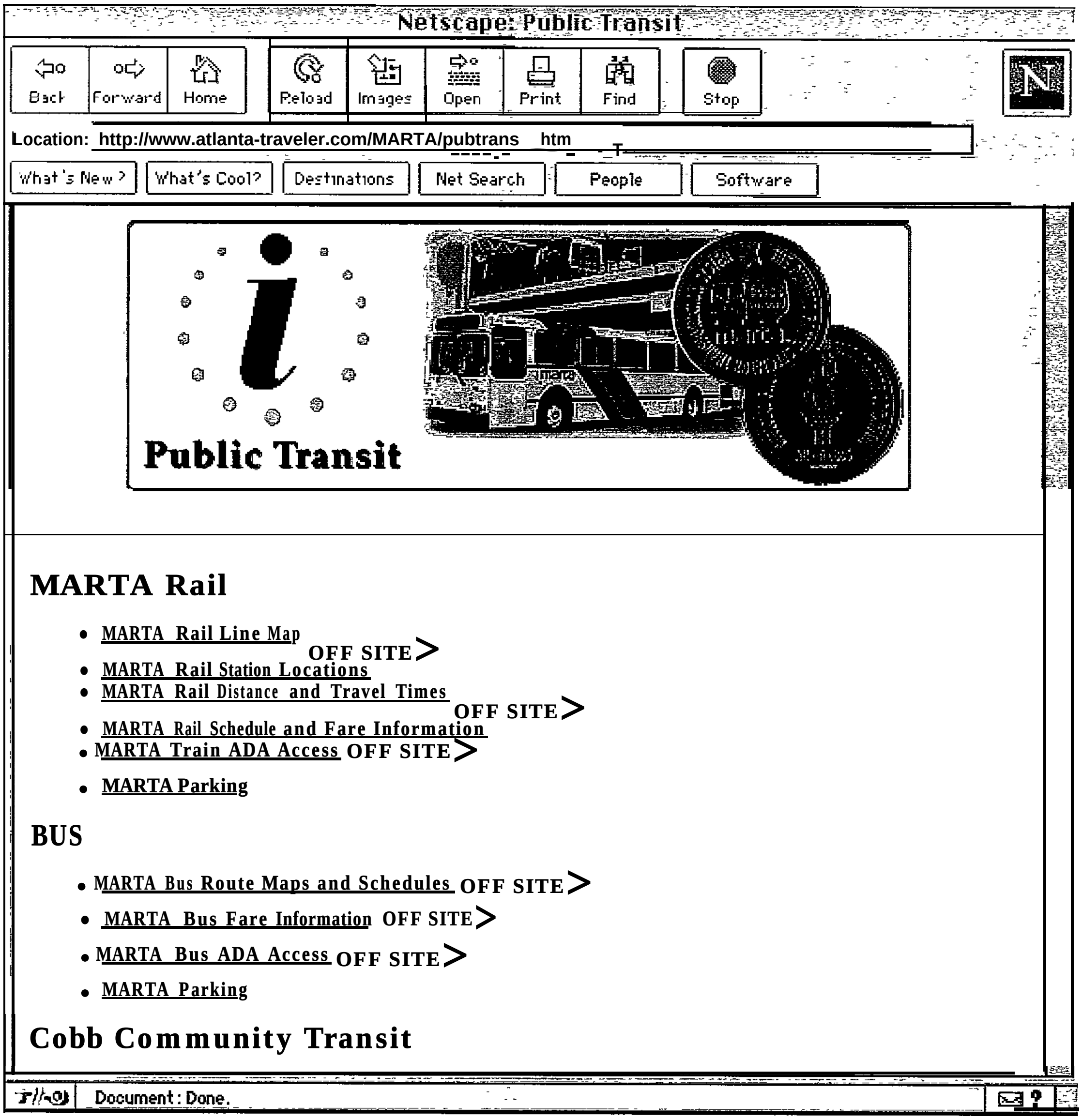


Figure 51. The Showcase Web site provided links to relevant external sites, such as MARTA.

While linking to other Web sites can greatly enhance the amount of information made available to users on a particular subject area, care must be exercised as to what sites are "connected." By the very nature of the Internet, a Web site developer has no control over the content of information made available on other Web sites. During the development of the TIS Web site, concern was expressed about linking to outside sites that may contain questionable content (such as adult-oriented material or inappropriate advertising). Consideration was given to providing no "link" to other Web sites to avoid this problem. It was decided that there was much more good and useful information available on the Internet than bad and to totally rule-out the external links would have a detrimental effect on the TIS Web page. To reduce any potential problems with outside links, the project team conducted careful screening of each potential link to determine the appropriateness of content. In addition, for each external link that was added, a clear indication that this was linking external to the TIS Web site was included.

- **Although it was a benefit to link to other Web sites on the Internet for information such as movies, restaurants, and lodging, there were precautions taken to ensure these links were accurate.** It is important for someone to physically check all links to different pages on at least a weekly basis. Several times it was discovered that other site locations changed their address, and thus the Showcases' links were incorrect and had to be updated.

- **While designing the georgia-traveler home page, obstacles arose concerning the Atlanta Project** Overview section. This issue stemmed from the two audiences interested in the Showcase: the public and the media. To remedy this impasse, two separate pages were created. All information on newsletters, partners, and technologies was located on the georgia-traveler page. A separate World Wide Web page was created which contained specific media material, such as press releases, and links to the georgia-traveler Web page for Showcase newsletters, partners, and technologies.

Cable Television

Cable Television

Showcase cable television was an integrated computer and video production system which automatically produced up-to-the-minute multi-media traffic information for distribution on an existing commercial cable television network. The major development of Showcase cable TV included creating a computer-controlled video production system (residing in the Georgia Department of Transportation's [GDOT's] Transportation Management Center [TMC]) and a distribution system which utilized a combination of fiber optic and satellite broadcast to the video head-ends (computers) at counties and the participating cable companies. The Showcase traffic information television program was known to viewers as Georgia Traveler Information television.

OBJECTIVE

The objective of the Showcase cable television system was to distribute useful, up-to-the-minute traffic information on the existing cable television network. The design of the Showcase cable television was based on the following rationales and concepts:

- Television is one of the most powerful and readily available media for distributing real-time traffic information to large audiences. In Atlanta, there were approximately 900,000 cable television subscribers who could potentially benefit from the Showcase traffic information.
- The Showcase cable television system intended to provide continuous Weather Channel-like traffic reports which would be more available than commercial radio or local television traffic reports.
- As part of the public service from the Department of Transportation, the Showcase cable television production system was designed to be intelligent and fully automatic, requiring minimal to no staffing.
- Showcase cable television produced a professional broadcast quality program (as opposed to text or simple graphic representations) directly from the Department of Transportation to the viewers without any post-productions or manipulations by the program distributors.
- Showcase cable television utilized the existing cable television network for distribution to avoid major capital investment. Participating counties and the City of Atlanta were able to incorporate the Showcase traffic television program into their existing public access channels without acquiring additional channels. Cable television companies were able to enhance their services to viewers by incorporating useful traffic information in the broadcast.
- Showcase cable television intended to create a public service with potential opportunities for private participation. The system could be modified to allow program distributors to insert commercials at specified times.

APPROACH

The approach to developing the Showcase cable television system required attention to two major elements: the cable television production system and a distribution network. The Showcase project team developed an integrated computerized video production system which automatically turned electronic traffic data and other available information into a professional multi-media presentation. The available traffic data and information included travel speed and incident data from the Showcase's fixed-end server (FES) and live highway surveillance video from GDOT. Two major efforts were involved in developing the cable television production system. The hardware and software of the system were developed by ETAK, Inc., and the presentation design was developed with the assistance of a local television production firm. The artistic inputs from the television production experts were incorporated into the engineering design of the system. The television production firm also produced professional animated video clips for use in the opening and between presentations.

The Showcase project team worked with local governments and cable television companies for the distribution of the traffic information program. Cobb, Gwinnett, Clayton, and DeKalb counties, and the City of Atlanta each operate a dedicated public access channel on the local cable television network. They were enthusiastic about carrying the Showcase traffic information program to enrich the current broadcast. MediaOne, the largest cable television provider in the Atlanta area, agreed to carry the Showcase traffic information program as part of their news services.

The major task of the distribution network was to establish a way to transmit the Showcase program from the GDOT TMC to the head-ends (computer and video devices designed for relaying video signal from one locale to another) at respective county and city facilities, as well as the MediaOne cable company.

Alternatives Considered

Cable Television Programming System Alternatives

The Showcase team considered two possible designs for the cable television programming system: a simplified design which encoded textual traffic information in the commercial television broadcast signal, and a more intelligent progmmming system which consisted of a combination of computers and video devices.

The simple closed-caption text encoding design approach is to encode textual data (traffic information) in the regular television broadcast (a similar scheme is used to achieve television closed caption). The textual data is embedded in the vertical blank line (VBL) between frames in the television broadcast and is, therefore, invisible to the viewers. The receiving ends (e.g., counties, City of Atlanta, and cable companies) can decode (extract) the textual data using a special decoder device. This textual data can then be used to overlay on a video graphic background to achieve a computer bulletin board-like presentation. The primary advantage of this approach is that it is technically feasible and simple with off-the-shelf devices and requires no additional distribution system. The textual data is embedded in one of the existing television channels and, thus, incurs essentially no cost for distribution. The disadvantage is the presentation capability. The textual information is not as informative as a multi-media presentation which employs video, animation, computer graphics, and sound.

The comprehensive multi-media presentation system is a computer-controlled video production system which automatically generates multi-media presentation based on the received real-time traffic data.

Such a system would have full data communication capability to receive and process the real-time traffic data from the Showcase fixed-end server (FES). By employing computer-controlled video devices, the presentation could include pre-recorded video and audio clips, computer graphics, music, and live video feed from the ATMS surveillance cameras. The advantage of a comprehensive multi-media presentation system is its ability to produce a professional multi-media presentation with a variety of material. The major challenge is, however, that no off-the-shelf commercial system was available to achieve the desired presentation. Such a system needed to be designed and developed within the compressed time frame of the Showcase's system development.

System Operation Alternatives

Two alternative system operation concepts also were investigated: comprehensive operator control and automatic with limited operator assistance.

Comprehensive operator control employs an operator to control the presentation. The types of control include changing presentation sequence, adding new material, creating a customized map to indicate an incident, or manually controlling the cameras and incorporating the selected highway surveillance video in the presentation. This approach allows for greater flexibility and variety in the presentation. The design, however, requires a near full-featured production studio which has off-line computer and video devices for generating new material. A skillful operator must be employed to comprehend the design functions.

The automatic-with-limited-operator assistance design creates a system that can achieve data communication with the FES and automatically create a professional-looking multi-media presentation with no human intervention. The system, however, does permit an operator to alter certain (limited) presentation features and add a live voice report to the automatic presentation. The advantage of the automatic system is the minimal staffing requirements with a capability of achieving professional quality presentation.

Distribution System Alternatives

The distribution system alternatives dealt with the method to transmit the Showcase traffic information program from the GDOT TMC to the participating local governments and cable television companies. At the time that the Showcase project began, fiber optic connection was available between the TMC and Georgia Public Television (GPTV), a state authority. Several fiber optic extensions were planned between the TMC and the local Traffic Control Centers (TCC) at Gwinnett, Cobb, DeKalb, and Clayton counties, and the City of Atlanta. Fiber optic connection was also planned between the TMC and MediaOne cable company.

Fiber optic line is the ideal way of delivering video signal. Due to the implementation schedule of fiber optic extension to the local TCCs, the Showcase project had to adopt a temporary solution to the direct fiber optic connections, specifically to utilize GPTV's available satellite channel to distribute the Showcase program. The Showcase traffic information program was transmitted from the TMC to GPTV. GPTV, then, uplinked the Showcase broadcast to the satellite with a transponder. This broadcast from the satellite covers all of North America and can be received with a standard satellite dish and a special decoder device. The arrangement required an agreement with GPTV(with a monthly fee) to use their satellite transponder and the purchase of decoder boxes to be installed at each participating agency. The advantage to using the satellite broadcast was the flexibility in expansion: there was no limit to the number of receiver units. The cost for a typical satellite dish and decoder box was about $4,500. The monthly fee for the satellite channel was, however, the only operation cost incurred in distribution.

Alternatives Selected

The Showcase team adopted the more ambitious design for the cable television programming system-a comprehensive multi-media presentation system, an integrated system of computers and video devices capable of communicating with the FES for real-time traffic data and commanding various video devices to achieve a multi-media presentation.

The core of the cable television programming system included two computers: a traffic work-station (data server) which processed data from the FES and a multi-media computer which executed a script to command various video devices. The available presentation material included the following:

- Professionally recorded video and audio clips that could be played back from a video recorder device

- Computer-generated graphics, such as congestion and incident maps, that used color-coded icons to present traffic information

- Four live highway surveillance video feeds from the Georgia Department of Transportation

- A traffic advisory bulletin board which displayed messages manually input by an operator

- Background music from a CD player.

A computer-controlled video mixer served as a conductor to arrange presentation sequence and provide transitional effects between scenes.

The system operation concept which the Showcase adopted was a fully automatic programming system with minimal or no operator intervention. The selection of the system operation was based on the following two primary rationales: from a public agency's perspective, avoiding or minimizing the cost of the operation was important, and the minimal control features of the system must be operable by non-technical personnel with minimum training. The selected system did not require any technical services in the daily operation. Limited features were reserved for the operator to control or to modify the presentation. For example, an operator could pause the automatic presentation in order to add live narratives. This feature was designed to be accessed by a professional traffic announcer with limited computer skill. Another operator control feature was to change the messages to be displayed in the traffic advisory bulletin board presentation.

Due to the fiber optic implementation schedule, the Showcase was unable to transmit the program via direct fiber optic connection to the participating agencies and cable company at the beginning of the operational period. For the period of demonstration (June 1 to September 30,1996), the Showcase utilized GPTV's satellite system as the vehicle of distribution. Satellite dishes and special decoder boxes were installed at each participating party's site to receive the Showcase traffic program from the satellite. As the fiber-optic connection to the various TCCs and MediaOne came on line, the distribution was shifted to a fiber system instead of the satellite. This allowed for the legacy broadcast of Georgia Traveler Information Television with minimal or no cost. By the end of the Showcase operational period Gwinnett and Clayton counties, the City of Atlanta, and MediaOne (which broadcast in Gwinnett, Clayton, DeKalb, Cobb, and Fulton counties) were all connected via fiber-optic cable.

IMPLEMENTATION

ETAK, Inc. developed the cable television progranuning system. The Showcase project team worked closely with the developer to design the detailed hardware and software specifications. The initial developments were conducted in ETAK's facility in California, and the system was installed in the GDOT TMC in early 1996 to continue the on-site integration with the FES for data communication, and incorporation of live surveillance video from GDOT's ATMS. The completed system was tested for data communication, presentation, and system stability, and beginning on June 1,1996, the Showcase traffic information program was distributed through GPTV's satellite to Gwinnett, Cobb, and DeKaIb counties, the City of Atlanta, and MediaOne cable company. Figure 52 shows the architecture for the cable television component of the Showcase.

The presentation design required a number of tasks, many of which were accomplished with the help of Jemnigan Productions, a local television production firm:

- The Showcase program was identified as Georgia Traveler Information television. A series of short video clips were produced for the beginning of a presentation cycle and between the presentations (called video bumpers).

- Canned audio clips were recorded by a professional narrator to be used with the beginning of each presentation segment (e.g., travel speed, incident, live video, and bulletin board). See Figure 53 for an example of a cable television message.

- Two metro Atlanta maps, for inbound and outbound traffic, were used to present travel speed information. Color icons complying with a common specification established for all Showcase devices were used to indicate the reported travel speed at each locale. The reason for separating inbound and outbound traffic was to simplify the information presented in each screen with much consideration given to the way viewers utilize information on television (see Figure 54).

- The duration of each presentation segment was thoughtfully timed to achieve the most efficient information presentation.

Figure 55 shows a graphical representation of the cable television production. The production was designed so there would be a clean break in the programming every 15 minutes on the quarter-hour to allow cable systems or operators a clean insertional drop point so they could transition into or out of the Showcase programming. As Figure 55 indicates, there were six “segments” that made up a cycle of the traffic program. These segments were an introductory clip, speed maps (both in-bound and out-bound), live surveillance videos (provided by GDOT), incident maps, a bulletin board (four separate messages), and a closing video bumper.

With the exception of the incident information, each segment was shown on every cycle and for a fixed period of time. The incident segment was the only segment that could vary on each cycle. If there were no active incidents (or road construction), this segment was skipped entirely. If there were incidents, the system first presented an overview map of the metropolitan Atlanta area with the incident locations identified by icons. From the overview screen, the map was broken into nine segments. Any segment that had an incident was then shown in more detail with all incidents within that segment numbered sequentially. While their detailed map was being shown, text (generated automatically by the FES and ATMS) describing each incident scrolled across the bottom of the screen.

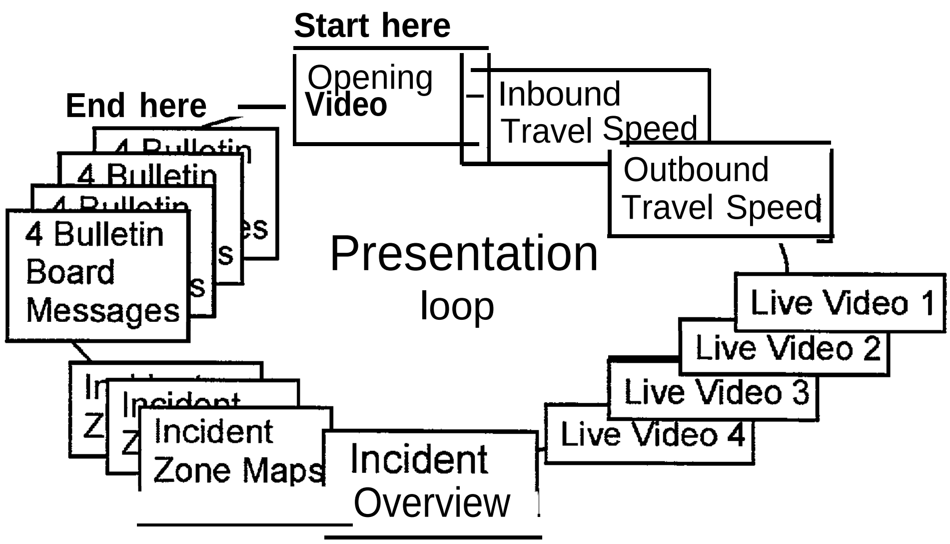


Figure 55. The cable television production cycle included six segments.

Because the incident segment added a layer of uncertainty in the duration of any cycle, prior to starting any new cycle the system calculated how long the next cycle would take. If sufficient time remained prior to the next quarter-hour break to complete the entire cycle, the programming proceeded as normal. If sufficient time did not exist, the system paused the programming cycle and filled the remaining time-until the next quarter-hour break-with rotating views of the live video surveillance cameras.

The negotiation with GPTV for distribution began in the early stage of the project. GPTV agreed to lease a digital satellite channel to the Showcase for distributing the traffic program. The Showcase then started the negotiations with Gwinnett, Cobb, and DeKalb counties. The City of Atlanta was later added to the distribution list. The three counties agreed to carry the Showcase broadcast during morning, noon, and afternoon rush hours on their respective public access channels. The City of Atlanta agreed to carry the Showcase program on a dedicated channel for a 24-hour continuous broadcast. MediaOne agreed to carry the Showcase traffic report for use in their dedicated news broadcast channel. Satellite dishes and special decoder boxes were installed at each participating agency where necessary.

Beginning in early 1996, Metro Traffic Network Inc. was contracted to provide live voice narratives to the Showcase program during morning (6 a.m. to 9 a.m.) and afternoon (3:30 p.m. to 7:00 p.m.) rush hours (see Figure 56). The training of the Metro Traffic Network reporters started in late April 1996. The reporters were familiarized with the Showcase cable television presentation and were trained to use a computer mouse to pause the presentation for adding narrations. A printer connected to Metro Network's traffic information system was installed at the Showcase cable television facility to provide additional information for live traffic report. The live report provided information and professional authoring of the presentation and greatly enhanced the Showcase program.

about liability issues associated with broadcasting live surveillance video. GDOT felt that any live surveillance video shown to the general public would have to be "monitored" to assure appropriateness of content. As a result, the program was developed to incorporate these four different "shots" into the programming sequence. However, as the system began to transition into a legacy system, GDOT was able to provide more video feeds (up to eight) that could be "cleared for public broadcast." However, since the initial number of video feeds was limited to four, increasing this to eight required a software modification to provide the flexibility to incorporate more video sources. It is important not to become preoccupied with meeting the stated requirements and losing sight of the vision of what the system is designed to do. The Showcase project team should have designed in from the beginning the flexibility to add and subtract additional camera feeds as they became available.

Interactive Television

As part of the Traveler Information Showcase, the project team developed an interactive television system which provided up-to-the-minute traffic information. The system was deployed in the Crowne Plaza Hotel, Ravinia, located in a northern suburb of Atlanta, This system provided useful, up-to-the-minute traveler information to the guests in the hotel through in-room television using a television remote control. The Showcase interactive television system included real-time travel speeds and incidents on the major highways, transit (bus and rail), airline information, local attractions and special events, yellow pages, and directions to specific locations.

OBJECTIVE

The objective of developing a Showcase interactive television system was to demonstrate the feasibility of disseminating real-time traffic information using the emerging interactive television service. Interactive television services have been adopted in hotels and have been used experimentally in residential areas around the nation. In hotels, the primary application of interactive television has been providing video-on-demand, displaying billing information (current balance or express check out), ordering in-room dining, and other hotel guest services. In the residential setting, the primary application is catalog services for on-line shopping. The Showcase interactive television integrated a communication capability with a commercial interactive television system for distribution of real-time traffic information. In addition, the Showcase implemented additional multi-media traveler information to create a truly useful traveler information interactive television system.

APPROACH

The project team used the following system development approach for the Showcase interactive television system:

- Create and implement a simple and flexible communications scheme to receive real-time traffic updates from the Showcase fixed-end server (PES). The communication scheme should be expandable and without major capital investments.

- Develop an enhanced interactive television system for providing useful traveler information including congestion, incident, multi-modal traveler information, directions, local attractions, special events, and yellow pages. To do so, in addition to the real-time speed and congestion information (received from the Showcase FES), new material was developed and stored locally on the interactive television computer server to fulfill the desired information services.

Alternatives Considered

The Showcase project team investigated two possible architectures for the interactive television system: a networked interactive system with two-way cable and a single hotel-based head-end system with a communication link to the FES.

The traditional cable TV (CATV) system permits only one-way transmission of information (from the CATV company to subscribers). A new fiber optic-based technology, two-way cable, provides wider bandwidth for simultaneous two-way communications. At the time of the Showcase planning, Atlanta telephone and cable companies had begun installing the cables in the metropolitan area. With two-way cable, a single head-end computer (computer server that contains the multi-media material and responses to end a user's request) would be able to provide interactive services to multiple hotels or residential developments. The communications between the interactive television head-end computer and the TMC could be facilitated by a connection to GDOT's fiber network. The advantage of two-way cable is the capability of serving a large number of interactive service users with just one head-end computer. The wider communication bandwidth of fiber optic provides faster data transfer and shorter response time. However, the project team had concerns about the timing of the fiber optic network installation, line leasing costs, and the higher cost for the two-way cable equipment.

A head-end computer residing in the hotel provided the interactive services to the remote television units in the guest rooms. A dial-up communications scheme using regular phone line or optionally dedicated digital line (which provides wider communications bandwidth and permits higher data throughput) was investigated for data communication between the FES and the interactive head-end computer. Most of the multi-media information would reside in the hotel resident head-end computer for faster response to the users' requests. The dial-up communication link would provide real-time traffic information (e.g., speeds and incidents) update from the FES. The major advantage of the hotel-based system was that it was immune to potential communication problems associated with a networked system. The dial-up communication scheme was flexible in terms of the location of the interactive head-end computer, and did not require major capital investments.

Alternatives Selected

The Showcase team selected the single hotel-based head-end system with the following specifications:

- A head-end computer residing in the Crowne Plaza Hotel provided the interactive services to 300 guest rooms. The two-way cable-based system, despite its much higher cost, was complicated by the uncertainty in the implementation schedule of the fiber optic network.

- A modem dial-up communications scheme was determined sufficient to provide one-way real-time traffic data updates from the FES to the hotel head-end server. Baud communication of 28.8K was sufficient for the real-time traffic data update.

- Multi-media materials were stored on the hotel head-end server in order to maintain reasonable response time to users' requests, which is a critical service performance measure.

- Set-top boxes were installed in the guest rooms to facilitate communications between the users and the interactive head-end computer. When logged onto the interactive television service, the telephone line (connected to the set-top box) in that particular room was seized to be used to transmit user requests (by pressing a button on a television remote control) to the interactive head-end computer. The requested information (multi-media video) was transmitted from the head-end computer to the user (set-top box) via the existing coaxial cable.

- Maintenance and information updates were performed remotely by the system developer using a reserved dial-in communication link.

IMPLEMENTATION

Negotiations with hotels in the Atlanta region began in July 1995. The Crowne Plaza Hotel, Ravinia, was chosen for the interactive television demonstration for three reasons: it is located in the northern suburb with convenient access to major highways (GA400 and I-285); a newly completed MARTA transit station, Ashford-Dunwoody, currently did not have interactive television services and had expressed enthusiasm and full cooperation to the Showcase development; and the area had a good mix of international (mostly English speaking) and domestic guests during the demonstration period who could benefit from the Showcase interactive traveler information services.

After the project team selected the interactive television architecture, the hardware and software development began at the system developer's facility in Dallas, Texas. Source Media provided a commercial interactive television system and reconfigured the hardware for the hotel application. Software modifications and new developments were made to facilitate the real-time traffic report for congestion and incidents.

The Showcase team worked closely with the system developer to create multi-media travel information, such as maps, pictures, descriptions, and directions to a list of selected local attractions/ restaurants. For real-time traffic information, travel speed maps and incident maps similar to those of the cable television channel were used (see Figure 57,58, and 59). For multi-modal travel services, MARTA bus, rail, airline, Greyhound bus, and Amtrak information was included. Event schedules, such as Olympic competitions and festivals, were available on the interactive services, and yellow pages with telephone, address, and printed directions were provided. Figure 60 shows a sample screen of the Showcase interactive television main user menu.

The interactive television system was installed in Atlanta in early 1996. The tasks required included installing the head-end server and rewiring telephone lines for use with the interactive system. In addition, 300 set-top boxes were installed and wired into the guest room television sets. The Showcase interactive service appeared as one of the channels on the hotel cable television services.

Part of the communication function of the Showcase interactive television system was provided by a PC-based data server developed by ETAK. The ETAK data server, located in the TMC, received real-time traffic data from the Showcase FES, and served both the interactive and the cable television systems. The data was processed, and redistributed to the interactive television head-end in the hotel. An analog dial-up line was used to provide communications between the ETAK data server and the interactive head-end. Figure 61 describes the Showcase interactive television system architecture.

LESSONS LEARNED

Several lessons emerged from the Showcase's demonstration of interactive television:

- **Enhanced traveler information increases system utility.** The Showcase team learned that, in the hotel application, services such as yellow pages, directions service, local attractions, and event schedules have greatly increased the utility of the interactive television system. The real-time traffic information such as travel speeds and incidents-although informative-require local knowledge to use effectively (e.g., plan for a less intuitive alternative route). The real-time travel speeds and incidents information might be better appreciated in a residential setting. However, for any successful interactive television application, information bundle is extremely crucial. A

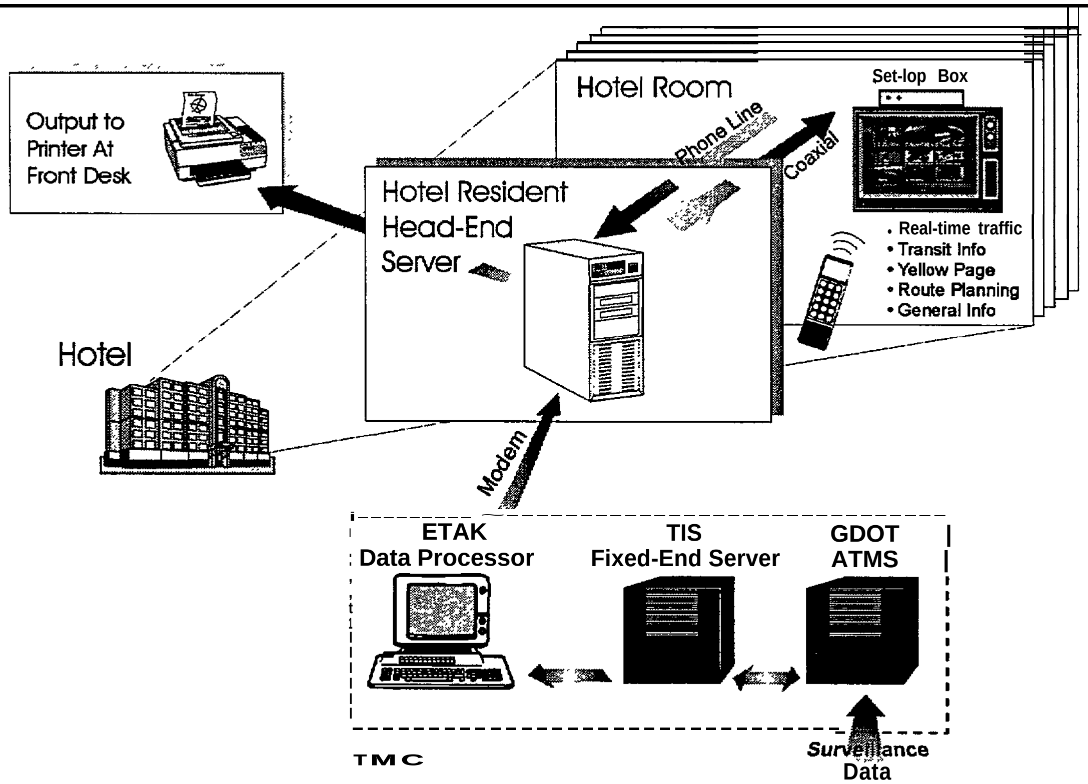


Figure 61. A PC-based data server received real-time traffic data from the FES and provided information to the interactive television head-end server.

smart bundle of information, in this case traveler information, can greatly enhance the utility of the system.

- **Use concise information for interactive television presentation.** Interactive television is sometimes confused with the information KIOSK. Television, however, is a more casual and entertaining device which should present information to viewers in a concise and intuitive way. Unlike the information KIOSK, the screen resolution of a television is considerably lower than those of kiosks (mostly high resolution computer monitor). The textual or graphical information on the television is viewed from a distance. Therefore, from a human factors standpoint, any lengthy, complicated information should be avoided on the television presentation. The Showcase adopted these empirical experiences learned in the interactive television industry to design the multi-media presentation. From the selection of type face and font size to the information contents, the Showcase worked closely with the developer to balance the detail and usefulness of each piece of information.

- **Avoid using a complicated menu structure.** It has been the rule of thumb, in interactive television development, to keep the user menu simple. A complicated or inconsistent multi-tier user menu can easily frustrate a user who is trying to find a particular piece of information. The Showcase team tried to limit the depth of the menu structure and to provide consistent navigation prompts at the bottom of all screens (e.g., prompts to go back to main menu, previous or next step). As a result, the Showcase interactive television system was one of the easiest to navigate and find useful information. A simple and intuitive menu structure also encouraged users to try out other information available on the system.

Technology Distribution and User Assessment

Technology Distribution
and User Assessment

Getting the Showcase technologies into the hands of users so they could experience the benefits of traveler information was an essential component of Showcase design. Their experience also needed to be captured and brought into the marketing and public relations activities of the Showcase. The assessment offered the Showcase valuable feedback from users about ways to enhance the uses and benefits of the traveler information. This section describes the many tasks involving users: recruitment; distribution, training, and support; and assessment. FHWA reviewed and approved the following plans for these activities:

- "Users of Atlanta Showcase Technologies: Recommendations for Recruitment, Distribution, and Promotion," Carol Zimmerman, December 18,1995
- "Plan for the User Assessment of Atlanta Showcase Technologies," Chris Cluett, March 1,1996
- "Training Activities and Materials for the Showcase Technologies: Identification of Needs," Susan Mangold and Carol Zimmerman, March 1,1996.

All of the plans are provided as appendices to this document under separate cover.

User Recruitment

OBJECTIVE

Recruitment was based upon two goals: achieving maximum exposure of the Showcase traveler information services and ensuring a positive experience with the technologies and benefits of the service. Reaching these goals was complicated by multiple objectives and constraints. For example, diversity and representativeness among users was sought, but that objective was balanced with the need to minimize the potential for problems that could adversely affect the user's experience. Thus, in recruiting people to use the PCDs, individuals with some prior experience with computers were sought to avoid the necessity of teaching basic computer skills.

Depending upon the technology, the task of recruitment consisted of one of two distinct efforts. First, some technologies involved recruitment of specific firms or individuals, as was the case for PCDs and in-vehicle devices. Other technologies involved raising awareness and encouraging usage, which was the case of cable television, interactive television, and the Internet Website.

APPROACH

To develop the approach to recruitment of users, secondary market research was conducted for insight into potential users of the Showcase technologies. The assumption was that the plans for the Showcase would benefit from an understanding of consumer behavior relevant to the technologies of the Showcase and the market acceptance of products or services similar to those in the Showcase. Among other findings, this investigation helped characterize the likely users of each technology under market conditions. The Showcase Website, for example, would be likely to attract the typical Web surfer: males, age 20 to 40. The Showcase cable TV program, on the other hand, would probably attract a much more diverse audience, similar perhaps to the popular Weather Channel, which is viewed by 24 percent of all adult cable subscribers.

Recruitment planning was also based on a review of selected ITS Field Operational Tests (FOTs) to benefit from the FOTs' experience in recruiting, training, and assessment of users. Managers of the following FOTs provided information: ADVANCE, DIRECT, FAST-TRAC, Genesis, Swift, Travlink, and TravTek.[14]

Alternatives Considered

To reach potential users and solicit their participation in the Showcase, a variety of approaches were considered:

- **Soliciting the general public through newspaper advertisements.** This approach would have been an expensive alternative, as a quarter to full-page display advertisement in the *Atlanta Journal* Constitution costs $10,000 to $30,000 per day, and multiple-day runs would have been required to be effective.

- **Seeking cooperation with employer transportation initiatives.** Some firms in the Atlanta area concerned about transportation problems might have heightened interest in solutions and, therefore, be good candidates for the Showcase technologies.

- **Involving the Atlanta Committee for the Olympic Games (ACOG).** ACOG would have a large fleet of vehicles and drivers that could provide valuable exposure for publicity purposes for the Showcase.

- **Seeking involvement of the American Automobile Association (AAA) to recruit travelers to Atlanta.** Through their membership, AAA has access to leisure travelers across the country and could directly solicit those coming to Atlanta. AAA had performed this function in the TravTek trial.

- **Seeking involvement of rental car companies.** Rental car companies could provide a means to get the in-vehicle devices in the hands of business and leisure travelers to Atlanta.

- **Seeking involvement of hotels in Atlanta.** Hotels could serve as agents for the Showcase technologies and provide access to visitors to Atlanta staying in their hotels.

- **Recruiting Internet Service Providers and computer retail outlets to promote the Showcase Website.** Companies dealing directly would come in contact with potential Internet users.

Alternatives Selected

In light of the available budget and the cooperation of the parties approached for participation in the Showcase, the following alternatives were selected for recruiting users of the Showcase technologies:

14 These field tests were conducted across the United States: ADVANCE (Chicago), DIRECT (Michigan), FAST-TRAC (Detroit), Genesis (Minneapolis), Swift (Seattle), TravLink (San Francisco), and TravTek (Orlando).

- **Work with Atlanta Chamber of Commerce to recruit member firms.** The Director of Transportation Programs at the Chamber sent letters to member firms to request their participation in the Showcase.

- **Work with the Hertz Corporation.** Hertz agreed to equip some of their vehicles in the Atlanta fleet with in-vehicle devices.

- **Work with Central Perimeter Transportation Task Force to recruit member firms. The** Central Perimeter Transportation Task Force, an organization of firms of all sizes located on the northern section of I-285, was receptive to using the Showcase technologies in their plans for dealing with the expected traffic congestion caused by the Olympics.

- **Involve the Atlanta Committee for the Olympic Games (ACOG) and the Atlanta Paralympic Organizing Committee (APOC) by having their staff of drivers use the devices.** By working with Oldsmobile in their capacity as supplier of vehicles to ACOG, the Showcase obtained ACOG agreement to use the devices to enhance publicity for the Showcase. These vehicles were subsequently turned over to APOC for their use.

- **Involve staff of federal, state, and local agencies proposed by FHWA.** Employees of government agencies in the Atlanta area could serve as users.

- **Establish VJP program for visiting celebrities, politicians, and media.** Devices could be made available on a short-term basis (e.g., 1 or 2 days).

- **Allocate part of HP2OOLXs to Hewlett Packard for user recruitment.** Hewlett Packard wanted to use their participation in the Showcase as a test market for traveler information services among their target market, business travelers. HP resources could expand the ability of the Showcase to recruit such users.

IMPLEMENTATION

Using the recruitment strategies outlined above, targeted visitors and residents of Atlanta were solicited for participation for the five technologies.

Personal Communication Devices

A total of 65 firms or government agencies located in the Atlanta region had employees who were users of the PCDs Thirty-four firms/agencies were recruited by Battelle and 31 were recruited by Hewlett Packard. At each firm or agency a person served as the principal contact for identifying other staff members for participation and for coordinating distribution and training of the devices with Showcase personnel. Most firms and agencies used the PCDs for approximately eight weeks, either from June 1 through July 31 or from August 1 through September 30. Fourteen firms or agencies who were using the PCDs during the first half of the summer and who expressed interest in extending that usage were permitted to do so.

Five hotels served as agents for distributing the PCDs to their guests. Battelle worked with the Embassy Suites in Galleria and Buckhead and the Sheraton Colony Square in mid-town Atlanta. These hotels offered the Motorola Envoy to their guests. The Embassy Suites Galleria participated throughout the entire summer, whereas the Sheraton and Embassy Suites Buckhead participated in the first and second half of the summer respectively. Hewlett Packard recruited two Marriott hotels, the

JW Marriott in Buckhead, and the Residence Inn in Dunwoody, to provide the HP2OOLX to guests. In addition to hotels, Hewlett Packard enlisted the staff at three SkyTel booths at the Atlanta Hartsfield International Airport to serve as distributors of the HP2OOLX.

VIP/media users of the PCDs were recruited in several ways. The Georgia Division office of FHWA actively recruited FHWA personnel from other regional offices who planned to visit Atlanta during the months of Showcase operation. This process yielded 16 responses from federal and state transportation officials, most of whom visited Atlanta during the Olympics. VIPs were also recruited through more informal means by Battelle making the program known at professional conferences and other types of networking. This approach produced 10 users for the VIP/media program, including people local to Atlanta, from other parts of the United States, and even foreign visitors. In addition, representatives from the media were recruited by Walcoff and Associates as part of their media relations program.

In- Vehicle Devices

From a total of 100 in-vehicle devices, 96 were available for distribution after allowing for spares and test units. Due to the time and cost of installation, the devices were left in vehicles the entire four months of the Showcase operation. Collaboration with the Atlanta Chamber of Commerce and the Central Perimeter Task Force was the primary means used to recruit companies with vehicles that could be equipped with the in-vehicle devices. Federal, state, and local transportation agencies were also offered devices for their fleet vehicles. A total of 46 devices were placed in fleets of firms and agencies in the Atlanta area.

Oldsmobile, as part of General Motors, used their official sponsorship of Olympic Games to enlist the Atlanta Committee for the Olympic Games to use 30 Oldsmobiles equipped with the in-vehicle devices as part of the official fleet. These cars were later used by the organizers of the Paralympic Games during their event in August. The Hertz Corporation agreed to equip 20 Taurus and Sable vehicles in their Atlanta fleet and make them available to renters. BMW, also an official Olympic sponsor, provided five cars to the Showcase and Oldsmobile provided three more. These eight cars were used to demonstrate the in-vehicle devices to visiting VIPs and media. Three of these cars were loaned to the Chamber of Commerce and *Southern Living Magazine* for the four months of the Showcase, and they were responsible for securing insurance coverage. The remaining five cars were used by FHWA and Showcase staff and were not available to others due to insurance restrictions.

Cable Television

Promoting the usage of cable television to residents where the Showcase signal was being broadcast was a challenging task. In the absence of a substantial advertising budget, a focused, less costly promotional approach had to be implemented. First, the four county governments in Cobb, DeKalb, Gwinnet, and Clayton counties were approached, as was the City of Atlanta, to identify potential techniques for reaching households in their jurisdictions. These jurisdictions provided the Showcase channel over their public access channel allocated to them by the local cable company. Only Cobb County was able to assist promotion by placing a notice in their newsletter to residents.

A second technique used to promote the cable channel was to enlist employers' help. The employers who were members of the Central Perimeter Transportation Task Force were contacted by telephone and asked to distribute a flyer to their employees. The flyer was prepared by Walcoff and Associates to be an eye-catching piece that would let people know what the cable channel was and where it could be accessed. Twenty-eight major employers agreed to distribute the flyer at their sites. This flyer also was provided to the Georgia Department of Transportation for placement at their visitor centers on roads leading into Atlanta in the hopes that visitors could also be made aware of the cable channels. Figure 62 shows one of the flyers used to promote cable television. Finally, Walcoff and Associates prepared written public service announcements (PSAs) that could be aired on radio stations in the Atlanta area to notify listeners about the availability of the Showcase cable channel. Fifteen radio stations agreed to use the PSAs.

Interactive Television

The Crowne Plaza, Ravinia hotel had agreed to let Source Media, the interactive TV firm participating as an ISP in the Showcase, install the interactive channel in 285 guests rooms. As a luxury hotel, the Crowne Plaza was reluctant to use aggressive promotional techniques for the interactive channel that might detract from their image and style of service. The first promotion approach used was an eye-catching tentcard prepared by Source Media that the hotel placed on the top of the television in each room (Figure 63). However, additional promotion was necessary when some of the early results of the user assessments revealed that many guests were not aware of this enhancement to the television in the room they had been using. Therefore, the guests were given an assessment questionnaire by the front desk upon check-in rather than at check-out as had been done up to that point. It was hoped that the questionnaire would serve as a means to attract attention to the interactive service and, thereby, promote greater usage.

Internet Web Page

Faced with the challenge of reaching a large and diverse audience of Internet users in their homes and workplaces, the Showcase Website was promoted with some of the same techniques used for the cable television service (see Figure 62). Public service announcements on 15 radio stations and a flyer distributed to employers and GDOT were the primary means of reaching out to potential users of the Website in Atlanta. In addition, the Showcase cable channel itself afforded the opportunity to place the Website address in front of thousands of viewers, as the address was shown as part of the programming on the cable channel. The Showcase also was linked to the Olympic and Paralympic Webpages, enabling additional Web surfers to reach the Showcase pages.

LESSONS LEARNED

Several lessons emerged from the user recruitment efforts:

- **Recruiting users proved to be a very** time-consuming **process.** Contacting firms or agencies to seek their participation often required multiple steps: making multiple calls to locate the appropriate person, sending material to explain the Showcase, demonstrating the PCDs and in-vehicle devices, and exchanging legal agreements. Weeks and months went by before all the recruitment activities **were** completed. However, many were very excited about the opportunity to participate in a unique technology demonstration.

- **Once recruited, users sometimes changed their minds and backed out.** Faced with competing demands for their time or overriding business objectives, some firms or individuals bowed out. This phenomenon manifested itself in the case of one manager who could never find time to have an in-vehicle device installed in his company car. In another case, an agency never returned telephone calls to schedule training for its employees on using the PCD. Such cases of attrition required additional Showcase resources to be devoted to recruitment activities to ensure that all devices were placed in usage.

Distribution, Training, and Support

OBJECTIVE

The Showcase developed a program of training and ongoing support to enable users to deal effectively with the technologies so they could realize the benefits of the traveler information services. Moreover, some devices, specifically the PCDs and in-vehicle devices, had to be physically distributed to their users.

APPROACH

Approaches to distribution and training were dependent on whether Showcase staff had direct access to users and the complexity of the technology or its familiarity to the average user. Thus, distribution of and training on PCDs and in-vehicle devices were primarily in-person by Showcase staff. The exception was for visitors to Atlanta, who received a PCD through a hotel concierge or an in-vehicle device through the Hertz rental office. Users of interactive television, cable television, and the Internet Website were self selected and self trained. That is, upon learning about the availability of one of the latter three technologies, the user decided on his or her own to take advantage of it and learned to use the technology through simple experimentation or through written instructions accompanying the technology.

Alternatives Considered

Among the alternatives considered but not implemented were the following:

- **Conducting training sessions at the Showcase facility.** This alternative was rejected as it was felt that users in general would not be sufficiently motivated to take time away from business or personal activities to travel for the training and distribution.

- **Asking Hertz staff to instruct renters on usage of the in-vehicle device in rental cars.** Hertz declined to do this, indicating they lacked sufficient personnel and that, moreover, many renters would be unwilling to delay their departure for such training. Moreover, the 20 vehicles equipped with the Showcase device was a tiny portion of the 8000 vehicles in the Hertz Atlanta fleet, and specialized training for so few users would have been unmanageable.

- **Having Crowne Plaza staff instruct hotel guests on usage of interactive TV in rooms. The** hotel declined to do this, indicating that front-desk personnel were too pressed for time to conduct such training.

Alternatives Selected

The distribution and training selected for each device was influenced by the characteristics of the technology itself and the access that Showcase personnel had to the users:

- In-person training on PCDs and in-vehicle devices, except for Hertz renters who were provided instructional materials in the vehicle

- Self-training on cable television, interactive television, and Internet Website
- Manuals and information cards provided for PCDs, in-vehicle devices, and interactive television.

For all Showcase technologies, a hotline telephone number was established to provide users seeking additional support a means to get such support or simply ask questions about the Showcase.

Implementation

Personal Communication Devices

For local firms and agencies whose employees were to be PCD users, the Showcase conducted a group training session of approximately one hour at their sites. At those sessions users were acquainted with the operation of the device and the use of the Showcase traveler information available. Manuals were provided for reference, and the Showcase hotline number was distributed. Before receiving a PCD all users were required to sign an agreement” to ensure the return of the device and to gain commitment for completing the user assessment questionnaire.

Personnel of hotels and SkyTel booths who served as agents for the Showcase also received the one-hour training session. They, in turn, trained and distributed devices to visitors. The training sessions conducted with visitors were abbreviated versions, with much more reliance on the manuals to inform visitors on the use of the device.

In- Vehicle Devices

The project team scheduled installation appointments for Siemens personnel, who did the actual installation. The team conducted a training session of approximately 20 minutes with each firm or agency receiving one or more devices. Brochures explaining use of the device and the meaning of traveler information icons were provided along with the hotline telephone number.

For devices installed in the Hertz rental cars, no in-person training was possible. Therefore, renter's attention was directed to the availability of the instructional brochure placed in the glove box by a sign mounted on the dashboard.

Interactive Television

In each guest room at the Crowne Plaza Ravinia a tentcard was placed on top of the television to provide simple instructions on use of the interactive channel (see Figure 63). The special remote control required to operate the interactive channel also had instructions printed on its back. Once the channel was switched on, the user could receive on-screen help by selecting the appropriate number on the screen.

Showcase staff provided training on the interactive channel to selected hotel staff who were likely to come in contact with guests on a regular basis: front-desk, bellstand, housekeeping, and concierge. The training was intended to assist them in answering guests' questions about the channel or help

I5 To maximize the number and representativeness of users of the PCDs, users were not held financially liable for the PCDs. Only one device was lost, indicative of the care that volunteers took in safeguarding the devices.

troubleshoot problems. The staff was also provided the hotline number for potential problems, in addition to the support provided by Source Media, who installed the interactive channel.

Cable Television

No specialized training was necessary for using the Showcase cable channel. On-screen instructions, both text and voice, were sufficient to inform viewers about the traveler information they were seeing. The hotline number was provided on-screen to answer viewers questions or other types of support. Indeed, cable viewers accounted for the majority of hotline calls.

Internet Website

As with all Websites, the Showcase Website was designed to be self-explanatory and easy to use. No special training was necessary. Users who did have questions or comments were able to correspond by e-mail or to call the Showcase hotline, the number for which was shown on the Website.

LESSONS LEARNED

The lessons learned in the distribution, training, and support stages of the Showcase included the following:

- **Distribution of Envoys to hotel guests proved difficult for hotel staff.** The distribution was time-consuming, and there were logistical problems, such as keeping the batteries recharged between users.

- **The Showcase hotline and Website provided important back-up to users. The hotline** received 180 calls, principally from cable viewers, who accounted for 61 percent of all calls. Next highest were PCD users who made 23 percent of the calls. The Showcase Website provided an automated means for users to ask questions, and 150 electronic inquiries were received by the Showcase staff.

- **Users did not always seek assistance with technologies.** Despite the efforts made to encourage users to contact the Showcase for assistance, we subsequently learned that many users who were experiencing problems did not attempt to get additional help.

- **Motivation and enthusiasm were important ingredients in a positive user experience.** During training sessions at some firms, it became clear that some staff had been recruited by their superiors and the subordinates did not always share the interest in the Showcase. For those users who were enthusiastic, they persevered in working through some of the occasional technical problems that occurred, such as the occasional communication problems experienced by PCD users.

User Assessment

OBJECTIVE

The overall objective of the user assessment was to understand the value of the traveler information provided through the Showcase from the perspective and experience of the user. The primary focus of the Showcase was to provide travelers with an opportunity to experience advanced traveler information systems. A related objective was to demonstrate that a set of technologies could be successfully integrated with a transportation management system to provide travelers with accurate, real-time information to assist with their trip planning and on-the-road travel decisions. A user assessment was added to the Showcase program because of the recognized value of gaining a better understanding of how the user viewed this system and its technology components.

Three months before the beginning of the Showcase, a user assessment plan was developed to guide a modest effort to acquire information from users of each of the five core traveler information technologies.[16] Specific goals of the assessment included an identification and better understanding of the following aspects of the uses of these technologies:

- Frequency and patterns of use
- Types of traveler information accessed
- Effects of this information on travel plans and decisions
- Perceived usefulness and benefits of both the devices and the information provided
- Comments and suggestions for improvement in information content and delivery
- Problems encountered and strategies for resolving them
- Characteristics of the users.

The user assessment was seen as a useful tool for better understanding how users perceive the potential benefits of the traveler information. It also provided a tool for monitoring the use and performance of the different traveler information technologies. User feedback was very helpful in considering mid-course adjustments that could resolve problems and improve the overalI level of service during the four-month period of the Showcase.

Finally, an important objective of the user assessment was to be able to derive lessons learned for future applications of traveler information technologies in other areas.

From the beginning of the Showcase program, user assessment was viewed as an important component but was not intended to be a major level of effort. The amount and detail of information that was collected from users was minimal, and the sampling of users was not scientifically designed. The objective was to provide a questionnaire to as many users as possible using samples of convenience and minimal follow-up with respondents. It was not the Showcase's objective to conduct a scientifically representative sample of users. As a result of this limited scope and level of effort, it will not be possible to generalize the assessment's findings to all users. What will be possible is to derive insight into how a subset of users responded to these technologies and the information they provided, and to better understand in a comparative framework how the different technologies were evaluated by users.

[16] *Plan for the User Assessment of Atlanta Showcase Technologies,* prepared by Chris Cluett, Battelle Seattle Research Center, March 1,1996. This plan is provided under separate cover as an appendix to this document.

Given more resources and time, it would be possible to follow up with many of these users to acquire greater detail and richness of data to gain an even better understanding of the users' perspectives and experiences. Such an effort will be left to future studies.

APPROACH

The approach to designing the user assessment was to identify the attributes of the Showcase traveler information system to be evaluated, decide how best to measure these attributes, and decide how to collect appropriate data to support the assessment. Each of the technologies called for a somewhat different approach to the assessment that would be sensitive to differences in form, function, and information content. Emphasis also was placed on preserving as much comparability across each technology assessment as possible.

In keeping with the limited scope and resources for the assessment, written questionnaires were prepared and distributed, rather than considering more costly and time-consuming approaches such as telephone or in-person interviewing, or large population surveys. Each questionnaire was kept to one sheet of paper, printed on both sides, with ample white space to keep it from appearing too dense. An on-line questionnaire was designed specifically for the Internet Showcase Web site that users could complete and submit electronically.

The content of the assessment was modeled to a limited degree on ITS evaluation models that are being used or developed in other related programs, such as the Field Operational Tests. Again, the objective was to provide some measure of comparability across studies of this sort so that learning about user needs and benefits might be cumulative. Each draft questionnaire was subjected to extensive review within the Showcase team and with the client. A pretest was conducted on the in-vehicle prototype questionnaire to be sure that question wording was clear and conveyed the meanings intended.

In order to encourage higher response rates, an incentive program was designed to support the user assessment. Systems were set up to make it as easy as possible for users to fill out and return questionnaires. Information relevant to the user assessment was integrated, where appropriate, with other components of the Showcase.

Alternatives Considered

Alternatives considered in the user assessment fall into several categories. These alternatives included such things as how to structure the questionnaire and word the individual questions, how to test and refine the final versions of each questionnaire, whether user data could be electronically "captured" by the system, the extent to which questions could be built into devices, ways to survey cable TV viewers, assessment management and follow-up procedures, and ways to encourage high response rates.

There was a vast array of possible questions that could be asked of users, but the one-sheet limitation on the questionnaire, coupled with the limited resources for data collection and analysis, constrained what information would be collected. The following assessment categories, concepts, or topics were considered in the assessment plan:

- Useability of the technology (device design, human factors, ergonomics, intuitiveness, complexity)

- Perceived value of the technology (perceived utility, impact, need, reliability, accuracy)

- Value of the information provided (distinguishes the device from the information provided by the device)
- Use patterns (how the technology is actually used in practice)
- Effects of usage on user travel behavior
- User attitudes and preferences
- User'characteristics
- Trip characteristics
- Problems encountered by user
- User suggestions for improvements.

In order to collect useful data on the concepts listed above, specific questions had to be framed to measure the concept in a logical, appropriate way. With this in mind, a list of questions was drafted for consideration, and this formed the basis for the final selection of questions and the wording to use in the questionnaires.

A draft assessment questionnaire was assembled for the in-vehicle device and distributed to selected Showcase and FHWA staff to fill out as a pre-test. The objective was to be sure the right questions were included and that the wording was clear and understandable. In addition, the questionnaires went through several reviews with the members of the Showcase team. Leaders of each technology reviewed the questionnaire designed for that particular technology. Their suggestions were incorporated into revisions of the questionnaire.

Consideration was given to ways that data could be captured directly by the device or by the fixed-end server (FES) to measure in precise detail how each user used the device. Such data might indicate, for example, that a user made five requests on a particular day at a particular time for route guidance to a specified location. These data could then be correlated with what the user said they did and how they evaluated such things as ease of use, quality of data, usefulness, and the like.

Consideration was given to incorporating short on-screen questions to make it easy for the user to respond at the time of use of the device, particularly the Envoy. This information could then be downloaded and analyzed along with the responses to questionnaires.

Cable television viewers were the most challenging set of respondents to evaluate. An effort was made to contact each of the city and county public access cable agencies to explore their willingness to use their customer lists to derive a limited random sample of viewers to whom questionnaires could be mailed. At the same time the Showcase was attempting to negotiate agreements with one of the principal cable television providers, which could have potentially afforded an opportunity to conduct a mailing with their support to their customer base. Unfortunately, this effort was unsuccessful.

Alternative strategies were considered for following up with employers, companies, hotels, and others who agreed to manage the distribution of devices and questionnaires on behalf of the Showcase. For interactive television this included distribution of questionnaires at various intervals, such as weekly or bi-weekly, handing them out with the check-out folder or during check-in, and providing a mail back envelope or assuming front desk drop off. Alternatives for the rental cars included different levels of involvement of their desk and garage staff in encouraging renters to fill out and return questionnaires. For the handheld devices consideration was given to maintaining close and frequent contact with distributors of the devices to assure the widest distribution to users and to encourage the completion and return of questionnaires.

Various incentives were considered for users to encourage filling out and returning questionnaires. These all involved users voluntarily providing their names and phone numbers to facilitate distribution of incentives to randomly selected winners.

Alternatives Selected

Selecting the user assessment approach was based on selection criteria that included the need to assure complete, reliable and valid data, and assure wide exposure to users. These alternatives are constrained by the need to conduct the assessment cost effectively to be consistent with the agreed-upon modest scope of this effort, and minimal inconvenience for Showcase supporters and respondents.

Samples of the six different questionnaires that were developed to evaluate user responses to each of the technologies are shown in Section A of the *User Assessment Appendix,* provided as an appendix to this document under separate cover. Each questionnaire reflects a core set of questions that are virtually identical, except for minor wording differences consistent with the uniqueness of each device. In addition, questions were included that were unique to each device. Questions were mostly "close-ended," meaning that the respondent only needed to provide a number or check mark. There were several "open-ended" questions on each questionnaire that required a respondent to write in a reply in his or her own words. Examples of open-ended questions in the Showcase user assessment include comments on problems encountered, suggestions, and a description of the user's occupation.

Respondents were given the opportunity to voluntarily provide their name and phone number in order to become eligible for both a bi-weekly drawing for a Showcase logo polo shirt and an end of the Showcase grand prize drawing for an HP2OOLX handheld computer. All respondents were assured that their identity would be kept confidential, and that only aggregate statistics would be presented in any reporting of the findings from this assessment.

Due to cost and time constraints, coupled with the technical complexity of trying to arrange for direct data capture of all user inputs to the device, as well as on-screen questions, these alternatives were dropped for each technology. General data were available that recorded "hit rates" for selected components of the Showcase Website, and data on the use of the interactive televisions were available. For each of the remaining technologies, it was necessary to rely on the questionnaire responses for information on use patterns.

The more detailed assessment procedures that were selected and implemented are discussed in the following section for each technology.

Implementation

This section discusses data collection procedures associated with each of the six technologies, general data entry and interim reporting, and implementation of data analysis.

Personal Communication Devices

In exchange for the opportunity to try out either handheld device (Envoy or HP2OOLX), the user agreed to complete and return a questionnaire. In most cases, an individual was identified who assumed responsibility for each device, as well as for completion and return of questionnaires by users of that device. Generally the plan was to complete the questionnaires and return them at the end of the period of use. Showcase staff contacted the device distributors periodically and picked up completed questionnaires; however, most questionnaires were collected when the devices themselves were picked up. This occurred twice, at the end of July and the end of September. It is likely that some users never received or knew about the questionnaire, particularly if their period of use was short. In cases where pickup was difficult, return envelopes were provided for completed questionnaires. An initial run of 1,000 questionnaires was produced for each of the two handheld devices. This proved to be more than adequate for the entire period of the Showcase.

Hewlett Packard managed the distribution of 60 of the HP2OOLX units. They conducted their own internal telephone follow-up with these users, and they also distributed the Showcase written questionnaires to their group of users. Completed questionnaires were returned to the Showcase office for analysis along with all the others.

In-Vehicle Device

Questionnaire packets were made up that contained sets of questionnaires, return envelopes, and a short notice about becoming eligible for a prize drawing by completing and returning a questionnaire (see Section B of the *User Assessment Appendix* for an example.) Each packet contained about a dozen questionnaires, plus a set of user instructions, and were placed in the glove compartments of the equipped vehicles. A notice was adhered on the front of the dashboard of the vehicle informing the driver about the assessment. Users were instructed to fill out the questionnaire and either leave it with the person to whom they returned the vehicle or mail it in the postage-paid envelope. Hertz personnel were responsible for assuring that the glove box always contained a sufficient backlog of questionnaire packets and for checking the vehicle for returned questionnaires when they were turned in. Vehicles that were made available to FHWA, Olympic staff, VIPs, and area employers were handled in a similar way. As with the handheld devices, persons managing the distribution of the in-vehicle navigation device, other than Hertz, agreed to see that a questionnaire was completed and returned by each separate driver. A total of 1,300 questionnaires were distributed for the in-vehicle device users.

Internet Website

A considerable amount of time was spent designing, testing, and fine tuning the set of questions and how they were presented to users of the Internet site. Initially, a link to the questionnaire was placed at the bottom of the home page. Later, given evidence that many users were going directly to the sub-sections of the site of interest to them, additional links to the questionnaire were placed on those more popular, transportation-related pages as well. Electronically submitted survey responses were received via electronic mail by Showcase staff for database storage and analysis. This required further manipulation of the electronic file to modify the e-mail format to a compatible database format. Only the Showcase logo polo shirt incentive was offered to respondents of the Web site questionnaire, given concern that the more substantial grand prize (an HP2OOLX) would attract disingenuous responses submitted solely for the purpose of trying to win a prize. The Showcase program made substantial efforts to advertise the availability and location of the Web site URL through published articles and direct contacts with other Internet providers.

Cable Television

Cable television represented the greatest challenge with respect to identifying viewers of the Showcase channel, getting questionnaires into their hands, and receiving completed forms back from them. Several different approaches were used.

First, cable television viewers who called into the Showcase hot line were asked whether they would be willing to fill out and return a questionnaire. Those who agreed were sent questionnaires with postage-paid return envelopes.

Second, the four local county governments and the City of Atlanta, which provide public access to public services cable television channel(s), were contacted to explore ways of surveying samples of their local cable television viewing constituencies. Cobb County agreed to include a short article on the Showcase, advertising the cable channel, in their July monthly flyer that is included with the water bills of approximately 120,000 customers. The article encouraged viewers to call the hot line with their comments, and also mentioned the Website URL.

Third, a script was developed for inclusion with the Showcase broadcasts which read, in part, “We need your feedback. Please, give us a call at [hot line number]. Just fill out a short comment form and you will be eligible to win . ..”

Fourth, extensive negotiations took place with MediaOne, one of the major cable TV franchises in the area. The intention was to work with MediaOne to distribute a small-scale random sample survey to their customers. Unfortunately, an agreement was never reached with MediaOne, so this strategy was abandoned.

Finally, before the start of the Showcase, selected employers in the Atlanta area were sent a flyer letting them know about the program, including the cable television and the Internet site. In early September, each of these employers was contacted and asked if they would be willing to distribute cable television questionnaires to their employees. Most agreed, and as a result, 1,570 questionnaires were distributed with postage-paid return envelopes. These were sent to the employers under a cover letter explaining the objective and encouraging each employer to distribute them to employees under a company letter head. The Showcase provided draft language for these internal cover memos. It was recognized that some portion of employees receiving these assessment forms would not have cable television in their homes. Also, this was clearly not intended to constitute a random or representative sample of cable television viewers.

Interactive Television

Showcase interactive television was provided to 285 out of 495 rooms in the Crowne Plaza hotel in Atlanta. Early estimates of the potential number of guests for whom questionnaires would need to be provided was over 10,000 for the four-month period. Therefore, it was decided early on to distribute questionnaires to hotel guests every other week for a total of nine weeks, seven days a week. Initially the plan was to provide a questionnaire and postage-paid return envelope with the guest’s bill, slipped under the hotel room door on the day of check-out. The guest could either leave the completed form in the room, drop it off with the concierge or front desk, or take it with them and either mail or fax it back. This approach proved not to be very successful.

As a result, the procedure was changed to distribute the questionnaire materials at the time of guest check-in. This was in itself a complex procedure because the hotel had decided not to alter its computer database on room information, and as a result the desk clerk had to look up each room against a written list of rooms equipped for Showcase. This resulted in some problems getting questionnaires into the hands of all guests staying in these rooms. Nevertheless, this system was much more successful.

During the Olympics, special group check-in procedures were used, and the questionnaire distribution process again suffered. Subsequently it was determined that the hotel reverted to including the questionnaire with check-out materials. Although this was corrected, the hotel shortly thereafter decided to discontinue the provision of Showcase, and all the equipment was removed from the hotel one month prior to the end of the Showcase period.

Throughout this period Showcase staff visited the hotel periodically to collect the bi-weekly questionnaires that had been returned by guests. A total of 5,000 questionnaires were produced and provided to the hotel for their distribution to guests.

Questionnaires

All originals of the questionnaires were sent to Battelle's Seattle office for entry into a database management system, further processing, and analysis. These were received either through diit mailing by the respondents using the postage-paid envelopes, by fax to either the Seattle or Atlanta offices of Battelle, or through direct collection by the Atlanta staff. All questionnaires received in the Atlanta office were forwarded to Battelle's Seattle office.

The questionnaires were date stamped upon receipt in Seattle, given an identification number, and organized in a set of three-ring binders by technology area. The data were then entered into a database using Microsoft Access. For all the paper questionnaires, the data were keyed in directly. For the Internet questionnaire, data were received via e-mail, and each transmission was manually converted into a format consistent with the Access data structure.

Throughout most of the four-month Showcase period the assessment data were kept up to date on a weekly basis and summary reports were provided to the Atlanta office for inclusion into a weekly report as requested by the client. This summary information included a table showing how many questionnaires had been received on each technology, both during the reporting week and cumulatively to date. Raw data tabulations were provided that showed the cumulative distribution of responses to each question for each technology. In addition, a separate report of the weekly comments regarding problems encountered and other comments or suggestions provided by users were compiled and submitted. An objective of frequent reporting on these user comments was to inform each of the technical leads for the six technologies of user problems and/or suggestions in order that fixes or adjustments could be made as appropriate and feasible. The user assessment served as a form of performance monitoring, providing critical feedback to help improve the delivery of traveler information on an ongoing basis.

The production of the descriptive frequency distributions on the data in the Access database was performed using the Statistical Package for the Social Sciences (SPSS-PC). More complex analyses, such as cross-tabulation of the data, could then readily be performed using SPSS-PC.

As noted earlier, various incentives were considered as a means of encouraging users to submit responses to the assessment. Two types of incentives were used, and they were described on a short notice that was attached to each questionnaire (a copy is attached in Section B of the User *Assessment Appendix).* A similar notice was included with the electronic version of the Internet questionnaire. All responses received in the Seattle office during a two-week period would be eligible for a random drawing for a Showcase logo polo shirt. There were eight drawings held every two weeks from the start of the program through to the end. In addition, a grand prize drawing was held at the completion of the Showcase, after all questionnaires had been received within the cutoff date of October 15,1996. The prize was an HP2OOLX, donated by Hewlett Packard for this purpose.

Data Analysis and Findings

This section reviews the main findings from the analysis of the data on each of the technologies and provides a brief comparative assessment of the results. Detailed results are presented in Section C of the *User Assessment Appendix* in tables with accompanying graphs for each of the closed-ended questions in the user assessments for each technology. This section covers the following aspects of the data analysis:

- An overview of the numbers of questionnaires received
- The estimated response rates to the assessment
- Some characteristics of respondents
- A discussion of the highlights from the data by technology
- A comparative analysis of selected data
- Observations regarding overall benefits and issues associated with the Showcase
- A discussion of the analysis of comments provided in open-ended format by the users
- A discussion of key assumptions that qualify the data analysis.

Response to User Assessment

Table 12 shows the numbers of devices of each technology type that were available to users in the Showcase. The Internet Web site was available to anyone in the world who had Internet access. The numbers of users is much more difficult to estimate. The figures on number of users in this table refers to users who are believed to have had both access to a device and the opportunity to fill out a questionnaire. This is not the same as the total number of users, for example, in the case of cable television viewers. Many viewers may have observed the Showcase broadcast, but only a few were given the opportunity to fill out a questionnaire. The numbers of users shown is a best estimate based on assumptions of use rates and exposure to the technology.

Between June 1,1996 and October 15,1996,755 questionnaires were returned for an overall estimated response rate of 8.2 percent. This is somewhat disappointing, given that users of many of the devices (handheld and in-vehicle in particular) agreed to fill out a questionnaire in return for the opportunity to participate in the Showcase test of these traveler information systems. In reality, some of the end users might not have been aware of that agreement, because the Showcase in many instances worked directly with employers, hotel operators, and rental car agencies, for example, and not always with the actual user or driver. The highest response rates were for the handheld devices, where the Showcase had the most direct contact with end users.

It is essential to recognize that these respondents do not constitute a statistically representative sample of a larger population of the Atlanta area nor of the Showcase user population itself. The inclusion of respondents was voluntary and not based on a random selection of all users or of all residents of the Atlanta area. For some technologies, an attempt was made to cover all users (handheld and

Table 12. Estimated Numbers of Showcase Users and Response Rates

	NUMBER OF UNITS	USERS WHO RECEIVED QUESTIONNAIRE	QUESTIONNAIRES RETURNED	RESPONSE RATE*
In-Vehicle	100	750	75	10.0%
Envoy	106	265	105	39.6%
HP200LX	116	230	64	27.8%
Internet	--	5,000	272	5.4%
Cable TV	~400,000	1,365	61	4.5%
Interactive TV	285	1,550	178	11.5%
Totals:	--	9,160	755	8.2%

* In-Vehicle: Includes 537 total Hertz rentals; estimate 2.7 users for other vehicles.
Handheld: Assumes 2.5 users per unit; some units were held back for spares or testing.
Internet: Assumes 2,500 "hits" a week; average of 8 visits per user over the four months.
Cable TV: Estimated number cable TV subscribers who received a questionnaire.
Interactive TV: Assumes 80 percent occupancy, 2 days/guest, 2.3 uses/guest, 50 percent received questionnaire

in-vehicle), but not for the others. Because users were self-selected into the assessment, it is likely that biases have been introduced into the findings, to the extent that respondents have different thoughts about the technology compared with non-respondents. It is important to keep this in mind when interpreting the results. Although not representative of a larger population, the results are certainly useful and instructive in helping to better understand how users interpreted the benefits of each technology. They are especially useful for making comparisons across each of the technologies. To the extent that there is consistency across sets of questions and across technologies, broader conclusions may be warranted.

Characteristics of Respondents

Evidence that the 755 respondents to the user assessment are not representative of the general population is apparent from the characteristics of the respondents shown in Table 13. Respondents were predominantly male (72.3 percent). The percent male among respondents ranged from 62 percent for cable television to 88 percent for the in-vehicle navigation device. The respondents also were very highly educated. Over three-quarters of all respondents reported that they have a college degree or higher. In addition, 97 percent of users of the Envoy, HP2OOLX, and in-vehicle devices reported that they have some or a lot of computer experience, 83 percent of the Internet respondents report themselves as experienced Internet users, and 83 percent of users of the Envoy, HP2OOLX, and in-vehicle devices report that they are comfortable using high technology products. While these characteristics are not typical of the general population, they do suggest that these users were more likely than average to be comfortable with and have the ability to figure out how to use these devices.

Analysis of Assessment Results by Technology

This section summarizes selected findings from the user assessments on each of the technologies. Full details on the distributions of responses to each question on each technology are presented in tables and figures contained in *the User Assessment Appendix.*

Table 13. Characteristics of Respondents

	AVERAGE AGE (YEARS)	GENDER (PERCENT MALE)	% COLLEGE GRAD OR POST GRAD
In-Vehicle	42.9	88.0	87.7
Envoy	40.4	66.7	80.4
HP200LX	43.8	84.4	88.9
Internet	40.3	74.9	68.9
Cable TV	43.8	62.3	55.9
Interactive TV	43.0	64.0	83.5
All Respondents	**41.8**	72.3	76.4

Personal Communication Devices. The 106 Envoys and 116 HP2OOLXs were available to the respondents an average of about a month (32 days for the Envoys and 27 days for the HPs). The average use by these respondents was 4.7 times a week for the Envoys and 6.1 times a week for the HP devices. The top two types of traveler information accessed by the users of both devices were current traffic conditions and route planning. Less than half of the respondents used these devices for information related to parking, transit, Olympic events, or wide area travel.

Figure 64 shows how respondents ranked 15 different indicators of level of perceived benefit provided by the two handheld devices. Respondents were asked to check one of five boxes ranging from whether they strongly agreed to strongly disagreed with the statement. The data points on the graph represent the mean (average) response over all respondents to each question, where strongly agree is a "5" and strongly disagree is a "1." A mean score of 3.5 or above can be interpreted to reflect agreement with the statement, and the higher the point is above that line, the stronger the level of agreement. Points between 2.5 and 3.5 reflect a neutral response, though this may reflect a balance between agreement and disagreement among respondents. Respondents to the two assessments on the handheld devices are remarkably similar to each other on every one of these dimensions of perceived benefit or device attribute/function. Responses predominately fall into the neutral zone.

A few observations on these data suggest the following points. Users liked the handheld devices as a way to present traveler information and generally found them easy to use. There was somewhat less endorsement of the accuracy and helpfulness of the information provided; 44 percent of Envoy users and 45 percent of HP users said that the information was helpful for trip planning. Users were apparently not likely to decide to purchase a device for their own use, assuming a reasonable (unspecified) price; only 28 percent of Envoy users and 36 percent of HP users said they would consider purchase. Based on comments to the open-ended question about problems encountered, users of both hand-held devices experienced difficulties with the wireless communications. That concern was reflected in the fact that only 21 percent of Envoy users and 30 percent of HP users said that sending and receiving messages worked well.

Users were asked to comment on any problems they may have encountered in using each of the traveler information devices. Over half of the 40 HP users and 57 Envoy users who reported having problems with these devices indicated they were related to communications. If we look at respondents

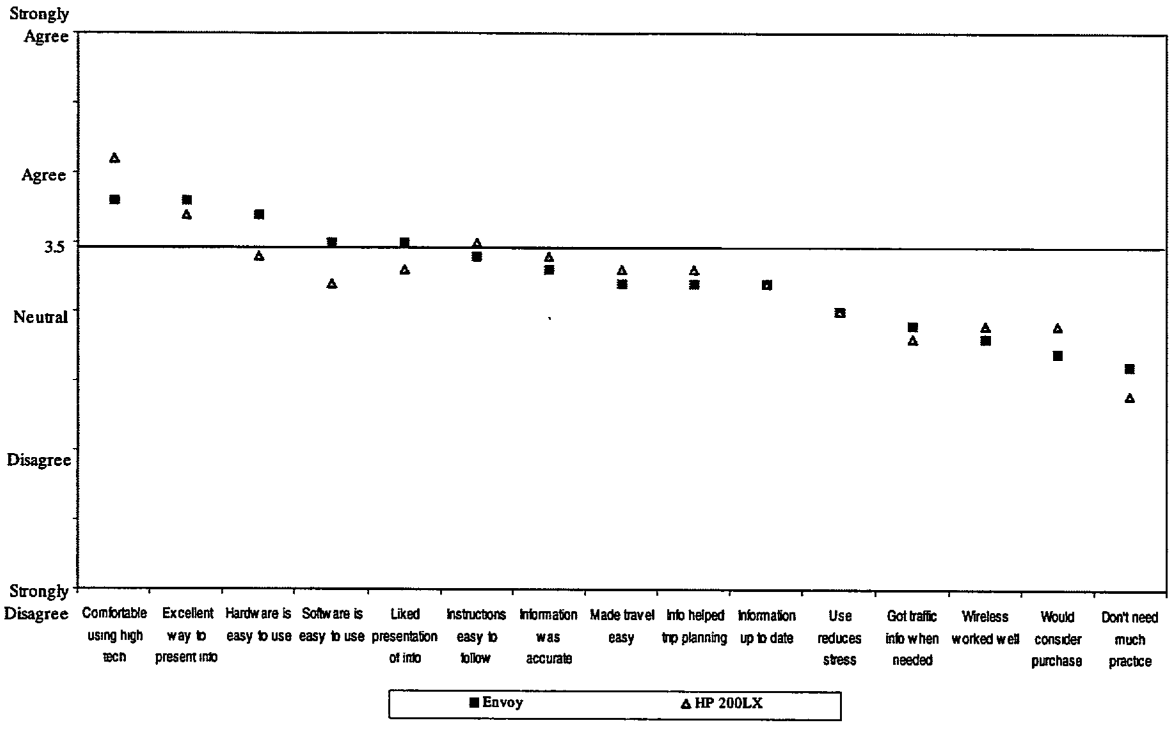


Figure 64. Users' perceived benefits of handheld devices.

to the handheld devices who did not report experiencing any problems, we get a different picture. For example, 70 percent of HP users and 60 percent of Envoy users who reported having no problems with the device said the traveler information was helpful for trip planning, or more than double the result for those who reported having problems. Also, for those users who did not report problems, 52 percent of HP users and 42 percent of Envoy users said they would consider purchase of the device for personal use at a reasonable price, substantially more than the proportion of those who reported problems who said they would consider purchase. The conclusion from this is obvious; the experience of problems significantly detracted from the perception of benefit among this group of users.

Figure 65 shows how respondents perceived the usefulness of each of the different categories of traveler information that they obtained from the handheld device. Between 50 percent and 70 percent of both Envoy and HP users reported that current traffic conditions were either somewhat useful or very useful and between 50 percent and 55 percent for route planning. Thus, even though they sometimes experienced communication difficulties obtaining this information, the information they did get was generally seen as useful. Wide area travel was both rarely accessed and not judged very useful when it was. The other categories fell in between in terms of reported usefulness.

The third main area of this benefits assessment was to look at the extent to which access to traveler information from the handheld devices influenced trip planning and actual travel behavior decisions. Figure 66 shows, again, that the two handheld devices exhibit almost identical results in this regard. About 40 percent of respondents reported that they changed trip routing and about 18 percent changed trip timing. Almost none of these respondents changed destination or mode of travel. About 60 percent said they made no changes in behavior as a result of the information they received.

It is important to recognize, for these handheld devices as well as for the other technologies, that the question that produced these responses only asked if the information ever once produced the behavioral effect. The average handheld user who had the device for a month presumably used it many times, and even if they said they changed routing once, for example, they are listed in that response category. The data do not reflect how often they made each change. Therefore, caution is needed in interpreting the strength of this apparent effect. The fact that over half of all handheld users said they made no changes in travel plans or decisions, regardless of how many times they used the device, does appear to be an important finding, however. Although some respondents checked both one or more behavioral changes and the no change box reflects the fact that they responded differently at different times, sometimes making a change and sometimes not. Any respondent who said they made a change was not also recorded as making no change.

As discussed in an earlier section, respondents were asked to comment on problems and to offer suggestions. For the handheld devices, 58 Envoy respondents and 43 HP respondents offered comments. Table 14 summarizes the general categories of comments received. A complete listing of all responses is included in Section D of the *User* Assessment *Appendix.* Some respondents offered more than one comment.

Table 14. General Categories of Comments for the Handheld Devices

NUMBER OF COMMENTS		SUMMARY OF COMMENT CATEGORY
HP 200LX	ENVOY	
24	37	Communication problems; too slow; out of range; couldn't obtain desired information
13	16	Complicated or awkward to use; hard to understand or work; too small; poor screen
5	2	Positive comments: intrigued by the technology; software works well; liked airline schedule info; fun to use
4	3	Incorrect information conveyed, inadequate information available
2	5	Battery problems

In-Vehicle Device. There were 100 in-vehicle navigation devices that were available to users. Those provided to renters of Hertz cars were likely used for only a few days each, while those assigned to VIPs and others in the Atlanta area were used for much longer periods of time by a single user, according to the responses. The average overall was 15.5 days of use by the 64 respondents to the user assessment who provided complete data on both the date they received the vehicle and the date they returned it. The 70 users who reported frequency of use said that they used the device for navigation an average of 3.2 times per day. All but one of these said they used the device to access route planning information (98.6 percent), and 60 percent said they used the device to obtain information on traffic conditions. About 51 percent accessed yellow pages information, and less than a quarter of users accessed parking, transit, or Olympic/Paralympic information. These data are all contained in Section C of the *User Assessment Appendix* tables for the in-vehicle device.

Figure 67 shows how respondents ranked 14 different indicators of level of perceived benefit associated with the in-vehicle navigation device. Most of these indicators fall high in the band of agreement, reflecting strong endorsement of this device and the traveler information it provided. The device and information attributes are arranged in descending order of perceived benefit. However, the differences on most of these indicators are not significant. The lowest ranked attribute falls in the neutral response area and indicates that only 32 percent of respondents agreed that they got traffic information when they needed it. Most (52 percent), however, were neutral on this question regarding the timeliness of traffic information. Although 45 percent of the in-vehicle users reported experiencing some kind of problem with the device, this did not appear to have any significant effect on their positive evaluation of these benefits.

Figure 68 shows how the in-vehicle device users ranked the usefulness of selected kinds of traveler information. Fully 100 percent of the respondents who answered this question said that the device was somewhat or very useful for route planning and the majority of them said it was very useful. Endorsement of the other categories was not as strong, with about half of the respondents indicating that current traffic conditions and yellow pages information was somewhat or very useful. Only 14 percent endorsed transit information in this way.

Figure 69 shows how respondents said that the traveler information obtained with the in-vehicle device influenced either their travel plans or travel decisions. Although 100 percent of these respondents said that route planning was useful, only 57 percent of respondents said they actually altered their travel behavior with regard to routing. Presumably others used the device to confirm a route they planned to

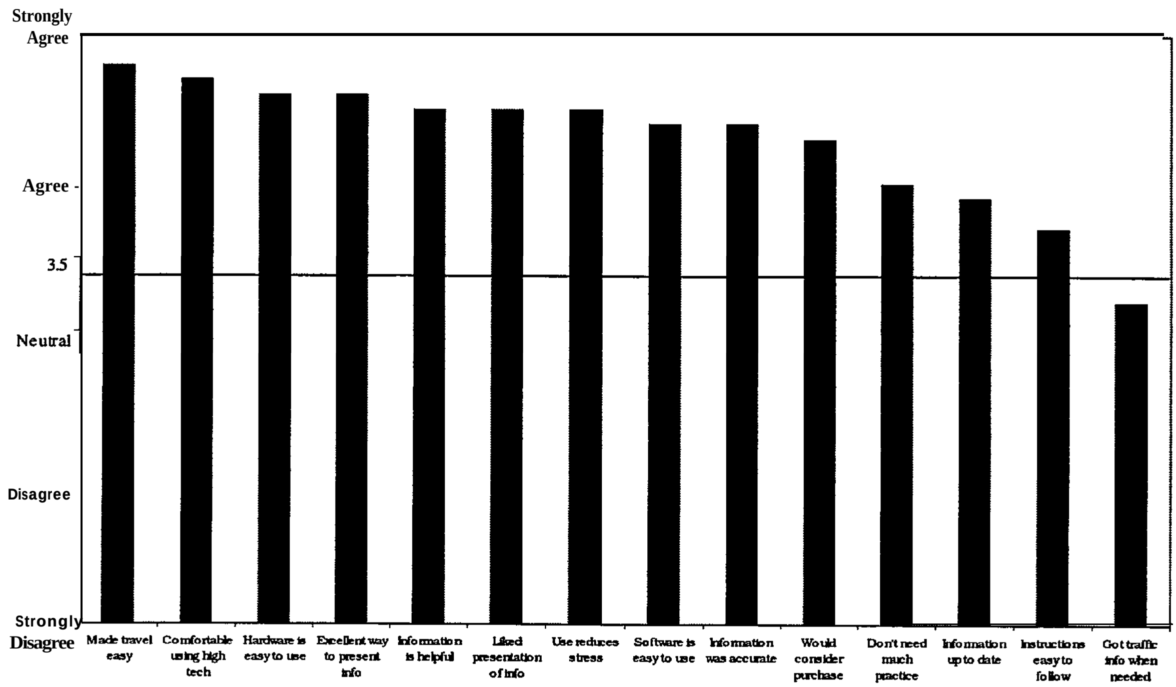


Figure 67. Users' perceived benefits of in-vehicle devices.

take anyway, or the device served to enhance their confidence in the route they chose or perhaps prevented them from straying off their route. Respondent users of the device rarely changed the timing or mode of their travel. Overall, 37 percent of these respondents said they made no changes at all as a result of the information they obtained from the device.

For the in-vehicle devices, 44 out of 75 respondents offered specific comments, either regarding problems experienced, suggestions, or general comments. Table 15 summarizes the general categories of comments received. A complete listing of all responses is included in Section D of the *User Assessment Appendix.* Some respondents offered more than one comment.

Table 15. General Categories of Comments Received for In-Vehicle Devices

NUMBER OF COMMENTS	SUMMARY OF COMMENT CATEGORY
22	Incorrect or inaccurate information conveyed; inadequate information available; GPS off actual location or not operating properly; inadequate address database; routed onto closed street; errors in map, directions, or addresses
16	General positive comments: excellent system overall; helpful device; info matched radio reports; yellow pages worked very well; user friendly; system has potential in spite of current limitations
10	Complicated or hard to use; hard to read, understand or work; route calculation took too long; input cumbersome: took a while to learn how to use; need improved instructions and functionality
6	System sometimes locked up or failed to work properly
5	Communication problems; too slow; out of range; couldn't obtain desired information; updates delayed
1	Concern with ability to use safely while driving

Internet Web Site. A very large audience of users potentially had access to the Showcase Internet Web site, which had an on-line questionnaire linked to it. Because this Web site was quite different from most of the other technologies, the kinds of questions that were posed to respondents also differed. This makes comparisons between the Internet responses and responses to the other technology questions somewhat difficult. Although information was recorded on the number of "hits" to each component of the Internet site, there is no way to know how many repeat visits there were, and hence how many unique individuals accessed the site, or different segments of the site. It is also impossible to determine how many individuals visited those parts of the site that had a direct link with the questionnaire; that is, many site visitors were likely unaware that a questionnaire was available.

Based on the number of hits recorded weekly and an estimate of repeat visits, we estimate that approximately 5,000 individuals visited the transportation components of the site that were linked to the questionnaire.[17] This resulted in 272 responses.

[17] The 5,000 estimated individual site visitors is based on an estimated average of 2,500 hits a week over four months and an estimated average of 8 visits per individual.

Figure 70 shows the weekly response pattern for the Internet Website. The period of heaviest response to the user assessment corresponds with the period of the Olympics, from July 19 to August 4,1996. This was also the period that corresponded with the most "hits" to the Showcase Website. The figure distinguishes first-time visitors to this site from those who reported more than one visit during the past week. Not surprisingly, the earlier period has mostly first-time visitors and the later period has more repeat visitors. There were very few respondents to the Internet questionnaire who responded to the assessment more than once. The average number of visits for repeat site visitors was 3.7 times in the previous week. The total number of visits for repeat visitors over the four months of the Showcase was likely fairly large, although this can not be determined from the available data.

Internet respondents were asked to rank the usefulness of the main topical areas that were accessible on the home page. Results are reported in the *User Assessment Appendix.* The transportation topic area was clearly the most visited and most useful component of the site, with over 94 percent of respondents visiting this area and about 85 percent reporting that it was somewhat or very useful. Roughly half of these respondents did not even visit the other site components, although those who did found those components useful as well.

Figure 71 shows how the Intemet respondents evaluated the usefulness of these transportation subareas. Real-time traffic conditions were seen as the most useful subarea by those who visited this area, with over three-quarters of these respondents indicating that the information was somewhat or very useful. Transit information was evaluated as useful by those who visited the transit subarea, though only 57 percent of them did. Only about half of all the Internet respondents said they visited the parking, wide area travel, route planning, or Olympic subareas. About 70 percent visited the Atlanta freeway map sub-area and 87 percent of those visitors said the area was somewhat or very useful.

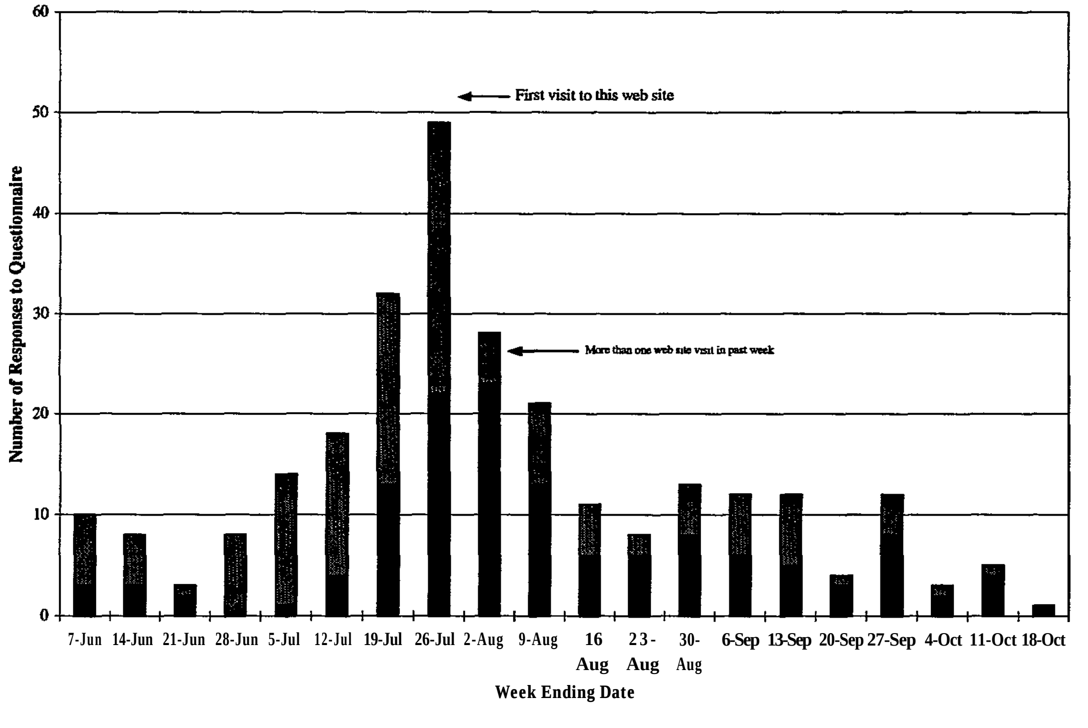


Figure 70. Weekly responses to the Showcase Internet Web page.

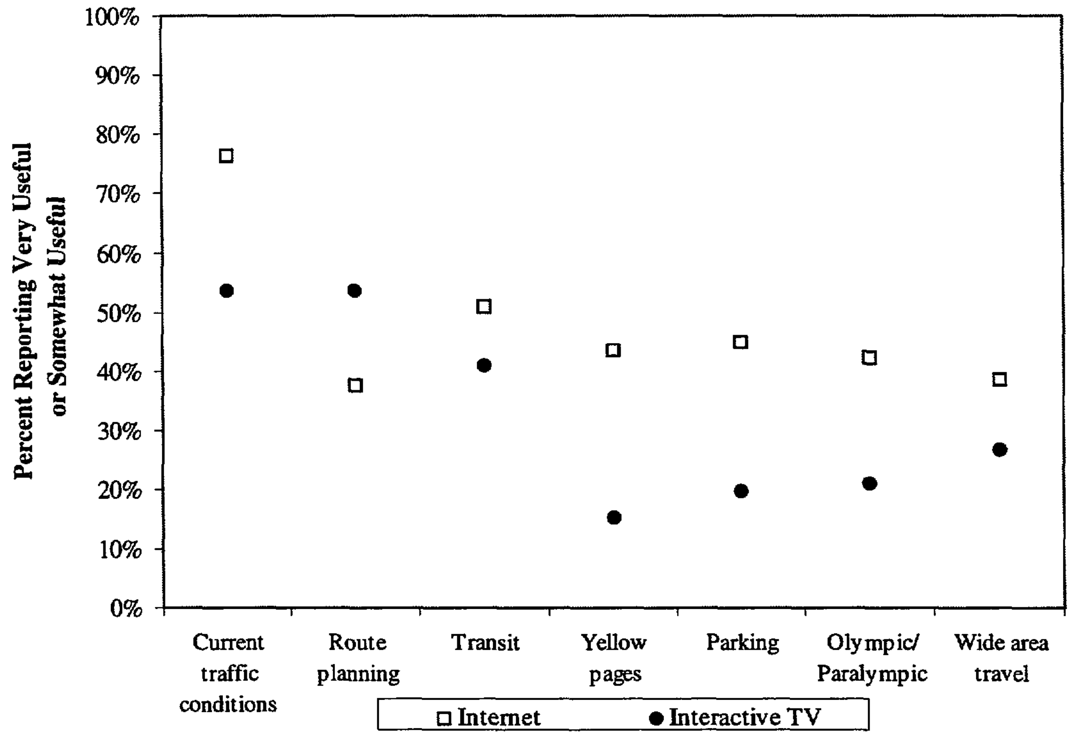


Figure 71. Reported usefulness of selected Internet and interactive TV information categories.

Figure 72 shows that the effect of traveler information from the Internet on travel plans or decisions follows a pattern similar to the handheld and in-vehicle devices. The information is most likely to influence routing behavior and least likely to influence destination or mode changes. More than with any of the other technologies, Internet users were least likely to say that the traveler information they obtained would cause no change in travel plans or decisions. Many Internet users reported that they visit the site in the morning and/or evening and pattern their commutes based on the information they obtain there.

Of the 272 respondents to the Internet site questionnaire, 163 or 60 percent provided comments or suggestions. Many comments were quite extensive, and Table 16 summarizes the general categories of comments received. A complete listing of all responses is included in Section D of the User Assessment Appendix. Many respondents offered more than one comment.

One user of the Internet site commented as follows: "Overall, I'm very impressed with the quality of this service, and I hope you keep working to improve it." This captures the sentiment implied in many of the comments and suggestions summarized in Table 16. Users appreciate what is now available, but they are looking for continuing improvements, and they have offered many specific suggestions for accomplishing this. The most frequently requested improvement was to add real-time camera shots at key locations on the freeway system.

Cable Television. As indicated in Table 12 and discussed above, there are several hundred thousand cable TV viewers in the Atlanta area but fewer than 1,400 of them are estimated to have received a questionnaire and thereby had a chance to respond to the Showcase user assessment. The 61 viewers who did return a completed questionnaire reported an average use of the Showcase public access channel of 4.6 times per week. All but one of the respondents reported themselves, not surprisingly, as Atlanta residents.

Figure 73 shows how the cable television respondents ranked 11 different indicators of level of perceived benefit associated with the technology itself or the traveler information provided by way of the cable technology. Several questions asked of cable television viewers were unique to that technology, so there is no point of comparison on some of these dimensions with the other technologies. Response patterns are quite consistent across the different indicators, falling in the band of mild agreement on most of them.

Looking back at Figure 72, we can see that the effect of the traveler information obtained on the cable television on travel planning and decision making is similar to that for the Internet Web site, with respondents generally reporting that the effects are a little weaker than for information from the Internet. About one-third of the cable television respondents report no changes in their travel behavior based on the cable television information.

The cable television questionnaire asked a unique question not presented to respondents of any of the other technology assessments. It said, "Briefly describe what information you found particularly *useful* that you obtained from the traveler information broadcasts on your cable television." Responses to this question were provided by 44 out of the 61 survey respondents. The following is a summary of the kinds of attributes of the cable television system that users found particularly useful:

- Location-specific traffic conditions
- Details on incidents; alternate routes; maps of trouble spots; construction areas
- Traffic volumes; average speeds; flow; congestion
- Real-time camera views
- Voice-overs that enhance video images
- Ability to view different locations
- Presentations that are easy to understand
- Early morning timing of program.

Of the 61 respondents to the cable TV questionnaire, 35 or 57 percent reported on problems or provided comments or suggestions. Table 17 summarizes the general categories of comments received. A complete listing of all responses is included in Section D of the User ***Assessment Appendix.*** Many respondents offered more than one comment.

About half of the respondents who identified problems or offered suggestions expressed confusion over the direction in which the cameras were pointed and the direction of the displayed traffic flows. Similar comments also were received on the hot line. This is an excellent example of the value of a user assessment. An unanticipated problem was identified through solicited user feedback, offering the Showcase an opportunity to substantially improve the quality of the cable television service.

Interactive Television. Of the 178 guests of the Crowne Plaza Hotel who had access to interactive television in their hotel rooms and returned a questionnaire, over 60 percent reported that they did not use this service at all. Many of the reasons are readily understandable, including a lack of time to watch any television, attendance at a conference that did not require them to leave the hotel, not being aware of the service, or because of problems with the service. In addition, especially during the Olympics, guest stays and travel were organized by company groups. Based on data on the total number of recorded uses of the Showcase system in the hotel, it is estimated that probably no more than 25 percent of all the guests who had the service in their room actually used it during their hotel stay.[18] This analysis reflects the views of those users (a small number to begin with) who returned the survey form.

The average length of stay by these respondents was 2.7 days, slightly longer than the average stay of two days estimated by the Crowne Plaza Hotel. The average reported use of the interactive television for accessing Showcase traveler information was 2.3 times for users who answered that question. The most accessed kinds of information by these users were weather (67.6 percent) and area attractions and restaurants (66.2 percent). Slightly over half of these respondents said they accessed information on current traffic conditions and/or route planning. About 24 percent of the respondents who used the system reported that the map printing option was somewhat or very useful. Only 19 guests among the respondents to this assessment reported they even tried this capability.

Figure 73 shows how respondents ranked 13 of the different indicators of level of perceived benefit provided by the interactive television. These responses cluster in a very similar pattern to the comparable responses from cable television viewers, and they reflect mild agreement on most of the indicators. About 44 percent of these respondents said they would consider purchasing a similar capability for their home television for a reasonable cost when it becomes available.

Figure 71 shows how interactive television viewers evaluated the usefulness of the categories of traveler information that were presented. Information on current traffic conditions and route planning were reported somewhat or very useful by about 47 percent of respondents who used the system, and about 40 percent said the same for transit information. The remaining options were rated less useful.

Figure 72 shows the effect that access to traveler information on the interactive television had on travel plans or decisions. Unlike any of the other technologies, fewer than 20 percent of users of this service reported that access to the information altered their travel planning or behavior. About 58 percent of users of the system reported that the information had no effect on their travel plans or decisions. Given an estimated 25 percent overall use rate for the hotel system, this reflects a small effect on travel behavior.

There were 71 users and 107 non-users of the interactive television system who returned questionnaires. Not surprisingly, non-users reported more problems with the system than the users, since many of these problems caused them to not use the system. Table 18 summarizes the general categories of comments received. A complete listing of all responses is included in Section D of the User ***Assesment Appendix.*** Some respondents offered more than one comment.

[18] Source Media reported 1,769 accesses from 279 of the 285 equipped rooms during the month of July. If we assume 80 percent occupancy, 2 days stay per guest, and 2.3 uses of the service per guest, that would imply 1,769 accesses out of 8,128 potential accesses, or about a 22 percent access rate.

Table 18. General Categories of Comments for Interactive Television

NUMBER OF COMMENTS		
USERS	NON-USERS	SUMMARY OF COMMENT CATEGORY
9	18	System didn't work; couldn't make system work; remote controller didn't work; system often busy; service not available in my room; difficult to use; interfered with regular television or phone
	15	Didn't need traveler information; didn't leave hotel: no time for watching television
1	9	Not aware that service was available
5		Service only partially functional; information too limited

Based on feedback from hotel guests to this assessment, and from hotel and Showcase engineers, significant efforts were directed to resolving some of the technical problems identified with the interactive television system. For example, the Showcase system frequently experienced interference with the Spectravision system in each hotel room. Also, the limitation of 20 channels for the Showcase programming sometimes caused hotel guests to not be able to gain access. Additional problems were associated both with informing guests about the availability of the system and providing guests with a user assessment form in a timely way and explaining its purpose.

Comparative Assessment Across Technologies

This discussion of the user assessment illustrates the complex nature of benefits evaluations for a group of traveler information technologies. The concept of benefits is multidimensional; that is, no one measure can capture a full sense of the benefit of these alternative technologies. Users see benefits to a greater or lesser degree both in the technologies (devices) themselves and in the traveler information that is provided through the conduit of the device. Users react to many attributes of both the technology and the information, and this user assessment has tried to measure some of these reactions. Components of benefit include ease of use and comfort with the devices, human factors aspects of the presentation of information, convenience of access to information, reliability and accuracy of the information, perceived usefulness of the information once obtained, functionality of linked support structures (such as the wireless communications system or the fixed-end server), and the utility and effectiveness of the information in altering travel behaviors. This short user assessment examined many of these dimensions of benefit, though it was not possible to probe in any depth into user responses to gain a more thorough understanding.

This section offers some selected comparative data across several of these dimensions, though users were never asked to compare these technologies directly. Figure 74 shows how respondents independently ranked each technology on several indicators of perceived benefit that have been discussed more completely for each technology individually. Not every technology is included in every indicator, because not each question was asked for every one of the six technologies. But the pattern of results suggests that the in-vehicle device was generally ranked the highest on these kinds of benefit indicators. Also, the two handheld devices were perceived to offer less benefit compared with the others. The remaining technologies fall in the middle between these two sets. It is important to note, however, that the average evaluation of degree of benefit on each technology across the full set of

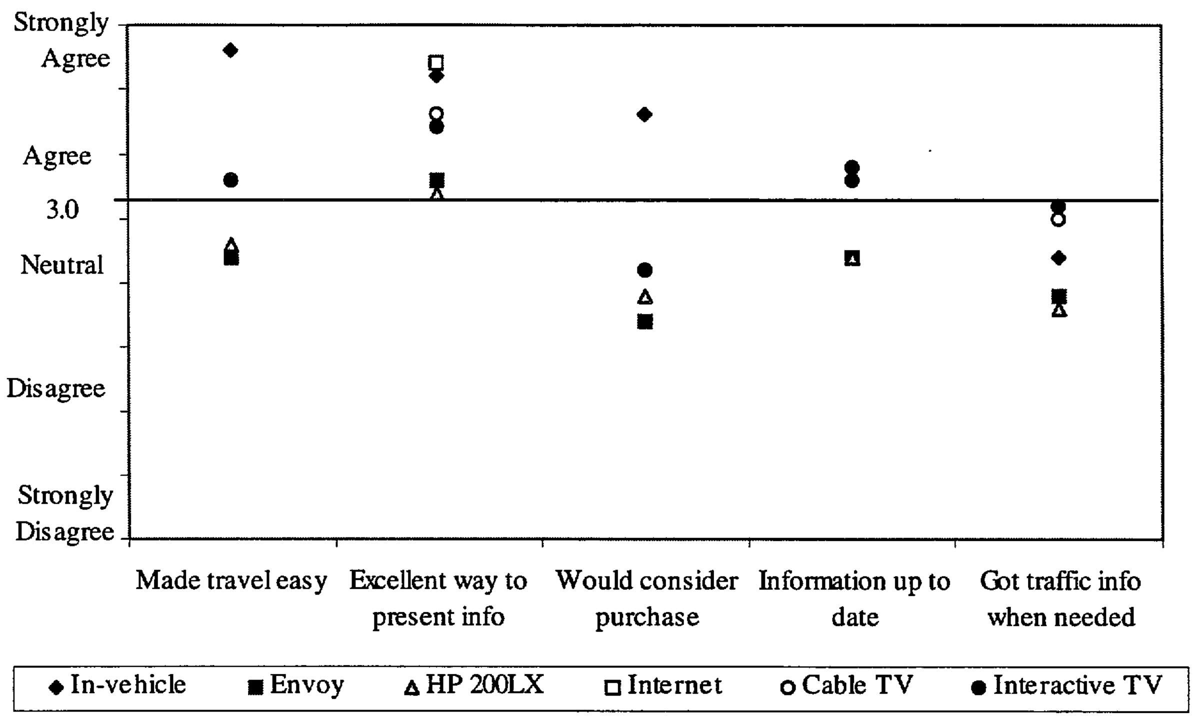


Figure 74. Users' perceived benefits of Showcase technologies.

indicators ranges from neutral (a balance between agreement and disagreement among respondents) to strong agreement. On some of these measures there is more uniformity of agreement than on others, reflected in the range of responses on each question. For example, getting traffic information when needed is important for the success of a system like this. For this Showcase trial period, this attribute was not ranked particularly high by respondents to any of the technologies. This may reflect some of the communications problems users commented on, rather than an evaluation of the device per sé.

The reported usefulness of the information derived from these technologies is another important indicator of benefit. As shown in Figure 75, this indicator conveys a somewhat different picture of the perceived benefits of the Showcase than the previously discussed set of measures. The most notable result is the 100 percent of respondents to the in-vehicle survey reporting that route planning was somewhat or very useful, whereas the responses on the other surveys fall in the 35 percent to 55 percent range. Information on current traffic conditions (real-time information) is generally perceived as quite useful across the technology groups. Interestingly, in-vehicle respondents rated this indicator lowest at 50 percent of respondents. Each of the other information categories was ranked somewhat or very useful by no more than half of the respondents. The Internet respondents evaluated the usefulness of the traveler information they obtained on the Web site generally higher than the other technology users.

As a final point of comparison across technologies, Figure 76 shows the percent of respondents on each assessment who said they made one or more changes in travel plans or decisions as a result of access to the Showcase information. Internet respondents are evidently more likely than users of the other technologies to change their travel plans or behavior as a result of the information they obtained through the Showcase program.

Some Cautionary Notes

The Showcase user assessment was a modestly scoped and budgeted effort from the outset that was intended to acquire limited feedback from users of the Showcase technologies. The questionnaires were limited to one page each (double sided) to minimize the effort needed for users to respond. As a result, it has not been possible, nor was it ever intended, to go into depth in investigating the many complex issues of use patterns, value derived by users, perceptions of usefulness and benefit, and related information. These kinds of more intensive evaluations that are typical of the ITS Field Operational Tests, for example, were far beyond the scope of this effort. We have tried to note in the analyses above where there are obvious limitations to the data and their interpretation.

An additional limitation that was noted at the outset is the non-representative nature of this survey. Given relatively low estimated response rates for each of the technologies, great caution must be exercised in ascribing results from this assessment to all users in the various technology categories. Given that there was no attempt to scientifically (randomly) survey the Atlanta population regarding the use of either cable television or the Internet, it would be inappropriate to make inferences from these results about how the general population may use or interpret the presentation of traveler information from the Showcase.

Some of the individual questions themselves are inherently limited in the information they are capable of conveying. For example, users who may have only tried out a handheld device once were asked to indicate average use per week. Furthermore, questions were asked about the usefulness of each of the. types of information provided, even though they could only answer once when they may have used the device many times over a long period of time. Findings from these kinds of questions are suggestive and helpful, but much more in-depth probing is needed to understand the more detailed patterns of use and benefit under varying conditions. This level of inquiry was simply not possible in this study with the limited resources and time available.

The wording of questions in any user assessment has a very significant effect on how respondents interpret the question and respond to it. Question wording can elicit different interpretations and responses among different respondents. Every effort was made to carefully structure and word the questions in this assessment to clearly elicit the desired information. The reader of this report is encouraged to review the actual wording of the questions contained in each questionnaire in Section A of the User Assessment Appendix and to judge for him or herself the interpretation of the findings reported herein.

The total number of respondents shown in the tables contained in Section C of the User Assessment Appendix for each of the technologies may vary due to non-responses. Each table contains the valid number of respondents for each question.

Analysis by Subcomponents of the Data

The data collected in this user assessment allow for some limited exploration of the relationships between use and benefit of traveler information, and gender and residence. This analysis is intended to be suggestive of relationships that may be worth understanding in greater detail, particularly if there is evidence that suggests males and females, or local residents and visitors, for example, have different reactions to each of these traveler information technologies.

There is some evidence that men are more comfortable than women with high technology products, that men may be more responsive to graphic presentation of information than women, and that women are more likely to plan ahead than men. Visitors to Atlanta, who are expected to be less familiar with the area, may find traveler information more useful, particularly for route planning. Because such a high proportion of males responded to the user assessments, there are not enough women in some of the technology samples to explore these kinds of relationships between gender and the presentation of traveler information by way of the Showcase technologies. For example, only 12 percent of the in-vehicle respondents were female. Likewise, the sample overall is predominantly composed of Atlanta residents (73 percent, not counting the interactive TV users for whom we do not have information on residence). We examined several of the samples where there were either enough female respondents or enough visitors or enough variation in the benefit variables to evaluate these links. It would be helpful to know whether women respond differently than men, or visitors differently than residents, in order to consider ways to tailor future programs to be more responsive to the particular needs of each group of users.

PCDs. Women in this group of users are more likely than men to say they experienced problems using both the Envoy device (69 percent vs. 47 percent) and the HP device (90 percent vs. 57 percent). Men in general may be less likely than women to admit having difficulties with technology. For every measure of perceived benefit from the Envoy (such as ease of use, information helpful for trip planning, and got reports when needed), men had higher levels of agreement (endorsement) than women. For example, twice the proportion of men as women said they would consider purchasing an Envoy at a reasonable price (34 percent vs. 15 percent), and 65 percent of the women felt the technology needed a lot of practice, versus 46 percent of the men. A significantly greater proportion of men (29 percent) than women (4 percent) agreed that sending and receiving messages worked well. Although the data won't support the conclusion that these relationships are statistically significant across the board, the consistent pattern in these findings is striking. A similar analysis could not be conducted on the HP user data given the small number of women in the sample.

About three-quarters of both the Envoy and HP user respondents were Atlanta residents. Fifty percent of the Envoy residents said that route planning was somewhat or very useful, while 73 percent of the visitors responded in that way, but there were no differences among the HP users. There were no differences among PCD user respondents regarding the usefulness of information for current traffic conditions. Sixty-eight percent of the Envoy user visitors said they made at least one change in their travel plans or decisions based on traveler information from the Envoy, while only 43 percent of Atlanta residents said they made a change. There were no comparable travel change differences for the HP users. Atlanta residents were almost twice, as likely to say they had a problem using the Envoy compared with visitors (58 percent vs. 32 percent), but there were no such differences among the HP users. Residents and visitors were no different with respect to perceived ease of use for either device, but visitors were more likely to say the information from the Envoy was helpful for trip planning (73 percent vs. 38 percent), reduced travel stress (50 percent vs. 25 percent), was up to date (77 percent vs. 35 percent), and that the route guidance made travel easy (77 percent vs. 3 1 percent). These relationships were similar but less pronounced for the HP users. Visitors appeared to have a much better experience sending and receiving messages on the Envoy than did residents (53 percent vs. 11 percent saying that it worked well). This effect was not evident for the HP device. Visitors were three times more likely to say they would consider purchasing the Envoy compared with residents (59 percent vs. 20 percent), and again this result was similar but much weaker for the HP users.

Cable Television. Among respondents to the cable television assessment, men are much more likely to report having problems than women (55 percent vs. 13 percent). In this case user response would appear to be directed more to the traveler information and the way in which it is conveyed than to the technology medium, as with the handheld devices. There was no clear pattern in the responses to the set of perceived benefit questions, and men and women are not significantly different in their responses to these questions. On the question asking whether the respondent views cable television prior to making trips, 53 percent of men agreed they did versus 33 percent for women, but the sample size is small. All but one of the cable television respondents reported themselves as Atlanta residents.

Interactive Television. As with cable television, there is no clear pattern of gender-based differences in perceptions of benefits in terms of various attributes of the technology. Male and female respondents were equally likely to find the technology easy to use, were equally likely to be inclined to purchase a similar system for their home, and say they are equally comfortable using high technology products. These respondents are those who used the system, not the non-users who didn't respond to these questions but there is no difference in the distribution of users and non-users by gender. Respondents to the interactive television assessment were not asked a question about residence.

Internet. Men were more likely to report themselves as experienced Internet users than were women (88 percent versus 70 percent). Men were also more likely to say they found real-time traffic information useful than were women (88 percent versus 73 percent). There was no difference, however, between male and female respondents on the perception that the Web site was helpful for pre-trip planning. Residents were somewhat more likely to find real-time traffic information useful (91 percent) than non-residents (62 percent), but on other measures of benefit and use of Showcase traveler information obtained over the Web site there were no differences between residents and non-residents.

LESSONS LEARNED

Even though this assessment was a small-scale effort to acquire some feedback from users, it offered a gold mine of insights and information from the perspective of users. Much can be derived from the thoughtful suggestions offered by the users that could benefit the application of traveler information technologies both in Atlanta and elsewhere. Lessons learned include what we have discovered from users about these technologies and the information conveyed by these technologies. In addition, there are lessons regarding ways to improve the conduct of assessments and how the feedback derived from these assessments can more directly benefit ongoing program efforts, as well as future programs. Readers of this report are encouraged to examine the detailed data presented in the User ***Assessment Appendix*** and draw their own conclusions based on these data.

Below are general observations about what has been learned in conducting this user assessment:

- **The user assessment process is not something to be undertaken only for experimental technologies; rather, it should be made an integral part of any technology deployment.** An overall objective of any of the numerous ITS programs around the country is to gain credibility with users and stakeholders. A fundamental lesson in the deployment of any ITS technology (indeed, any technology) is the importance of recognizing, understanding, and being responsive to the needs of the users of that technology. The user is our most important client. Failure to meet user needs usually spells failure of the technology, regardless of its engineered excellence. User assessments, such as this one conducted for the Showcase, is one of several ways to assess user needs. Credibility and buy-in can be obtained through a process of soliciting user input and demonstrating responsiveness to that input.

- **User feedback needs to be taken seriously.** A user assessment serves as a monitoring tool that allows program managers to keep their fingers on the pulse of the program and how it is interacting with the end users. If we are going to ask users for their suggestions for improvement, then we must be prepared to act on the basis **of** that input. The short timeframe for the Showcase provided limited opportunity to make modifications in response to user feedback. Future deployments, however, should be designed with this in mind, including establishing at the outset appropriate institutional arrangements and resource commitments.

- **Commit resources so that a comprehensive assessment can be conducted.** Limited resources do not usually allow active follow up with respondents and usually results in lower than desirable response rates. Results, as in this case, are not easily generalizable to broader populations of users, and the ability to interpret the results is thereby limited.

- **Engage users in the process early.** Regardless of the experience base of the team working on deployments of this type, it is difficult to anticipate how the full range of potential users and stakeholders will react to and value the outputs or deliverables of the program. The only way to know this is to engage users early in the process and to pay close attention to what they are saying.

- **It is an open question as to whether there is an underlying propensity for users to contribute negative versus positive comments.** That is, are respondents more likely to give fair and useful feedback compared with non-respondents? There did appear, however, to be a genuineness and constructive bent to the many comments and suggestions submitted by these respondents. In this Showcase assessment, suggestions were thoughtful and constructive in most cases, and were voluntarily contributed by about 62 percent of all respondents who used these technologies. This user assessment elicited more than 400 individual comments from users. Very few comments were mean spirited; almost all were constructive and in many instances insightful. It is important to remember that the assessment specifically solicited input on problems experienced, with the objective of learning from users how to improve the delivery of traveler information. Where concerns were similar across users, the message was clear-this is a problem that needs to be addressed before the full potential of this technology can be realized.

- **User-reported data are vulnerable to biases.** These derive from differences in interpretation of the assessment questions asked, differences in understanding of the nature and content of the program, different backgrounds and needs, and a host of other complex factors. The link between expressed attitudes about technologies and actual subsequent behaviors with those technologies is very tenuous. Results from this assessment are most usefully and appropriately interpreted as suggestive. Patterns in the data are probably more useful than specific percentage estimates. And, as has been noted above, volunteered user critiques and suggestions are extraordinarily valuable for guiding future improvements, in addition to real-time program adjustments. A lesson for future programs like this one is to do more to acquire direct data on how users are using the system. For example, have counters on the FES or TMC that count hits, or otherwise identify and record the kinds of requests that users are making. These data are better, more complete, and more reliable than what users subjectively report back (particularly given relatively low response rates from user surveys). It is crucial to know what users think about the service and technology, but the additional data would help substantially. Typically with relatively little additional investment of program resources, this can be accomplished, but it needs to be planned from the beginning and incorporated into the program design.

- **It is important to make user response as easy as possible for the user.** The quality and quantity of the Showcase assessment responses would have been improved, for example, by incorporating a short set of questions directly into the hand-held PCDs. One advantage is that the user's reactions are fresh in their minds and can be recorded immediately. Also, it is easier to assess multiple uses of these technologies on a use-by-use basis, instead of trying to summarize a complex set of experiences after weeks or months of use.

- **A successful user assessment requires frequent stuff attention onsite to be sure everything is running smoothly, to follow up on any problem areas, and to be sure questionnaire recipients are living up to their commitments.** The onsite staff should have some measure of background, training, or familiarity with evaluation methods.

Legacy Operations

Legacy Operations

During the initial planning of the Traveler Information Showcase in 1995, the Federal Highway Administration clearly established the project's goal: demonstrate the state of the art in traveler information technologies in Atlanta, Georgia during the Summer of 1996. The Showcase daily operations proved the effectiveness of traveler information services, and the project also illustrated the feasibility of public-private partnerships through the successful participation of independent vendors who provided cutting-edge ITS technologies and in-kind contributions.

However, a third goal also emerged during the Showcase planning stages. FHWA recognized that with the infrastructure already in place in Atlanta, leaving a legacy of travel surveillance and information dissemination made sense. And it underscored an important aspect of this ITS demonstration: the focus of the Showcase was to turn the promotion of ITS technologies away from transportation professionals and toward the public. Continuing to provide the ITS benefits for the public after the Showcase ended would allow FHWA and the Showcase participants to continue to promote ITS technologies to the public.

With this goal of legacy operations in mind, planning for successful continuation began almost as soon as planning for the overall Showcase. From the beginning, vendors and systems were selected that first provided the best opportunity for a successful demonstration during the Summer of 1996, but second provided the best opportunity or platform for continued private sector operations. As the Showcase systems were designed and the architecture implemented, the focus was always to maintain an open architecture to allow for ease of operation, ease of access for new systems, and consistency of developmental approach.

At the completion of the full-scale operational period on September 30,1996, there was concern that if any or all of the Showcase systems were allowed to stop operating, the likelihood that any of them would be picked-up and "turned back on" was very slim. Based on these concerns, the Showcase and FHWA arranged to continue, but in scaled-down operations. Any possible legacy system would require a public-private partnership between GDOT for collecting and disseminating the information and the private sector for continuing to operate the Showcase systems. FHWA and Battelle agreed that the Showcase would continue uninterrupted operations through the end of February, 1997. This continued operation would focus on providing a place where interested parties from around the country could come to see these state-of-the-art traveler information systems. However, the Showcase did not continue to distribute devices such as the PCDs and the in-vehicle devices to the public.

The following sections describe the status of each Showcase system's continued operations through the end of February, 1997 and its potential to remain operational as a legacy system.

SURVEILLANCE

The Showcase continued to maintain and operate the 51 surveillance sites installed for the full-scale operations. These devices continued to feed real-time information to both the Showcase as well as GDOT's ATMS. The supplemental surveillance coverage provided by Metro Networks was continued, but on a reduced level. Traffic reports were forwarded to the TIS operators during the morning and afternoon rush periods.

In November, at the direction of FHWA and GDOT, the Showcase began incorporating live speed information provided by the GDOT Autoscope™ cameras on Interstates 75 and 85 inside the Perimeter (I-285). When this switch occurred, Metro Networks was no longer used to report speed information inside the Perimeter, but they continued to provide their supplemental coverage to the Showcase for outside the Perimeter and other areas where GDOT and the Showcase do not have coverage.

GDOT has agreed to take ownership (including operational and maintenance responsibilities) of the Showcase installed surveillance hardware. As long as funding remains, the Showcase will continue to maintain'and operate these devices, but GDOT has agreed to pick up this responsibility when the Showcase no longer can. A memorandum of understanding (MOU) was developed which outlined the equipment to be transferred, the operational and maintenance requirements of the equipment, and the agreements on the part of GDOT, FHWA, and the Showcase regarding transfer of ownership.

FIXED-END SERVER

TRW was tasked with continuing the operations of the fixed-end server through the end of February, 1997. In addition to keeping the FES running and interfacing with the information distribution devices, TRW focused considerable resources on enhancing the FES operations to better integrate operations with the GDOT ATMS and thus facilitate seamless legacy operations. Several capabilities were added, such as the ability to control Showcase slow-scan cameras directly from ATMS operators' consoles.

GDOT also has agreed to take ownership and maintain and operate the FES when the Showcase support ends. Ownership and responsibility for all of the hardware and software will be transferred to GDOT. An MOU was developed for the FES that outlined when and how the system would be transferred to GDOT as well as the operational requirements of the system.

INFORMATION DISTRIBUTION DEVICES

Each ISP device or system was handled separately to determine operations beyond the end of September 30, 1996.

Internet

The Showcase Web site (www.georgia-traveler.com) remains operational, and agreements have been reached to continue this system as a legacy operation beyond the end of February, 1997. The Showcase has continued to support and maintain the Web site during continued operations. Minor enhancements were made to the system to remove references to the Olympics and other special events that were completed in the Summer of 1996. GeorgiaNET, a state authority for the state of Georgia, has agreed to take over operations and maintenance of the Showcase Web site. As part of the legacy negotiations, the Showcase agreed to fund an enhancement to the Web that will allow Internet users to view "snapshots" of the GDOT live video surveillance cameras directly from the Web site. Once this modification has been implemented and fully tested, GeorgiaNET will assume responsibility for operations and maintenance of the Showcase Web site.

Interactive Television

This system will remain as a legacy in the Atlanta area At the completion of full-scale operations, the Interactive Television (ITV) system was removed from the Crowne Plaza Ravinia Hotel and re-installed at a local apartment complex in the Atlanta area. The system, in a slightly modified form, has continued to operate and receive the real-time information from the TMC during the continued operations.

This installation at the apartment complex is part of a two-year experiment between Source Media (the company that developed the ITV application) and the apartment complex. An MOU was drafted that detailed the agreement among GDOT, Source Media, and all other parties to continue to provide the real-time traffic to this lTV system at least for the next two years. Continuation beyond the end of 1998 will require further negotiations between GDOT and Source Media.

Cable Television

GDOT has indicated they are very interested in the cable television system remaining as a legacy system, and has agreed to support its operation (without a live voice talent) until they can privatize it. GDOT does not have the resources or skill-base to maintain this system on a long-term basis. The Showcase has continued to operate the cable television system during the last phase (until the end of February 1997), broadcasting the traffic programming 24-hours per day. However, the satellite broadcast through Georgia Public Television, which ended when the full-scale operational period closed, is being distributed through the fiber optic connections of MediaOne, Gwinnett and Clayton counties, and the City of Atlanta to the GDOT TMC.

For legacy operations beyond February 1997, the cable television system has required the most complex negotiations of any of the Showcase systems. Not only are the skills and services needed to maintain the equipment and continue production of the programing, but the signal must then be broadcast into the cable systems in the Atlanta area. The Showcase has made use of the services of the Georgia State Privatization Commission to assist in the negotiations to privatize this system. As of the date of this report, no final arrangement have been made but several organizations have expressed an interest in potentially operating the cable television system. One of the biggest obstacles that must be addressed is providing the ability for a private operator to generate revenue (advertisements or sponsorship) from their programming to cover operational costs and provide a profit potential. Without this arrangement, the private sector will not be interested.

In- Vehicle Navigation System

It is uncertain (as of the date of this report) whether the in-vehicle system will remain as a legacy system beyond the end of February 1997. The 20 units purchased by FHWA during full-scale operations continue to operate and the real-time traffic information is still broadcast through the DCI FM-Subcarrier. However, the remaining 80 units that were part of the Showcase operations have been returned to Siemens (they were leased equipment) for disposition. Siemens was able to sell many of these units to the individuals who used the equipment during full-scale operations, but Siemens did not release the exact number sold.

Negotiations are still under way among Siemens, General Motors (Oldsmobile division), DCI, Zexel, and Navigation Technologies to determine the interest in maintaining the system in Atlanta. As of the date of this report, no resolution has been reached.

Envoy Personal Communications Device

The Envoy PCD system will not remain as a legacy. The Envoy application (Strider) was maintained during the continued operations period. Unlike full-scale operations, no Envoys were distributed to the public. Only 10 Envoys were maintained with active communications links through the ARDIS radio network. The project team and FHWA agreed on the importance of continuing to demonstrate the wireless 2-Way communications through a personal communications device. The 10 Envoys are maintained by Showcase operational staff at the GDOT TMC and are available for tour groups and VIPs that visit.

The Strider application will not continue as a long-term legacy system. Fastline Traffic, a San Francisco-based software development company responsible for the Strider application, has no plan to market this application commercially in the Atlanta area, and GDOT is not able to assume responsibility for the application. In addition, serious questions have arisen over the past six months regarding the future availability of a suitable hardware and software platform for this application. Motorola has announced they will no longer be manufacturing Envoys. Sony, which manufactures the MagicLink (similar hardware device that uses the same MagicCap operating system as the Envoy), has indicated they will stop manufacturing these devices as well.

HP 2OOLX and SkyTel 2-Way Pager Personal Communication Device

The HP PCD system will not remain as a legacy. The Personal Travel Guide (PTG) software developed for the Showcase to operate on the HP 200LX still can be demonstrated at the TMC; however, the live communications are no longer operational. The SkyTel communications link from the TMC was disconnected in early October. Hewlett Packard indicated from the very beginning of the Showcase that their participation would focus on a testing a product rather than developing an application and/or product that would be mass produced and made available to the public. As a result, all the equipment associated with this system was leased for the Showcase and returned at the completion of the full-scale operational period.

For the continued operational period as well as legacy demonstrations, HP donated five of their 200LX palmtop computers and SkyTel donated three of the 2-Way pagers. The Showcase purchased the 20 mb flash disks that stored the PTG software for each of these five devices, which allows static demonstration of the functionality of this device. Historical traffic information (e.g., speeds, construction, accidents) have been stored on the device to allow demonstration of the “look and feel” of the application, as it was during full-scale operations.

Results, Accomplishments, and Lessons Learned

Results, Accomplishments, and Lessons Learned

The Traveler Information Showcase (TIS) was a unique project: in only 16 months, the core team, led by Battelle, would select vendors to provide the required technologies; establish subcontracts and define and establish the individual partnerships; develop and modify software as needed, develop system testing; integrate the systems with other Atlanta intelligent transportation systems; select and train users; set up a hotline for help; distribute devices; establish an operations center, install a traffic and incident surveillance system; and develop a comprehensive outreach and public relations program. The following summarizes the Showcase project team's experiences, which hopefully will benefit others who are installing similar technology demonstration programs.

Public-private partnerships are essential, and important issues must be considered in structuring the relationships.

The Federal Highway Administration (FHWA) conceived of the Showcase as a public-private partnership from the beginning. One of FHWA's clearly established objectives for this project was the demonstration of five selected technologies: personal communications devices (PCDS), in-vehicle route guidance devices, cable television, interactive television for hotels, and on-line systems (e.g., Internet). Meeting this objective in the available 16-month time frame required commitment and flexibility from both the public sponsor and the private investors who would provide the devices.

In putting together the partnership program, it was important not to get bogged down in the past and the way things always have been done. In this project, we found that all parties, including the U.S. Government, were willing to negotiate and work in new ways. Maintaining flexibility and exploring new avenues when necessary allowed everyone to accomplish the objectives of the project.

Creating this kind of partnership requires attention to a few key issues:

- Allow time for negotiation of partnership agreements. The Showcase negotiations took much longer than ever anticipated at the beginning of the project. Several of the subcontracts took months to finalize.[19] In all cases, partnerships included financial or in-kind contributions by both parties. For a company to commit their own resources usually required the involvement of senior managers, which often led to numerous meetings and approvals, and required more time. Negotiating partnerships can take months, not weeks.

- Private enterprises need to see a potential return on their investments. When companies were approached to participate in the Showcase and were told that the partnership required an in-kind contribution such as hardware, software, or other resources, every company's first question was

[19] Time was a problem for the Showcase. When a subcontractor was identified, the Showcase initiated work with a purchase order agreement with limited funding to initiate work. Therefore, each subcontractor was working even while the partnership agreement was being defined and negotiated. This is ill advised, but was essential to meet the Showcase schedule.

about the benefits that would justify their investment. The benefits to both parties need to be clearly articulated. Jn cases where a "win-win" strategy could not be defined early in the process, establishment of the partnership failed. The private sector is in business to create profits. In negotiations and project execution, it is essential to work with each company to define creative methods for profit generation and to protect their ability to generate revenues. The sensitivity to profit generation goes a long way to gaining a company's trust and partnership participation.

- When a private enterprise is making an in-kind contribution, they will want to own it at the end of the project. The partnership must define system ownership at the beginning of the project. Hardware ownership was usually clear, as it was determined by who had provided the money. However, software ownership was not as easily defined. Ownership can be complex when both public and private funds are used for development (which is occurring in more and more ITS projects). In the subcontracts established, it is important to define clearly ownership of the results and long-term use rights.

Conduct the project as a true partnership.

Every effort was made for all participating companies to work together as a team. Showcase management knew up-front that the technology vendors would encounter unforeseen problems. When problems were discovered, all parties operated in an "above-table-mode" and worked together to resolve the issues. Cooperation is absolutely essential for a project that requires multiple inputs that must work together. Shifting the paradigm from the traditional contractual relationship to a sense of partnership kept the team working together to meet the Showcase objectives.

Furthermore, the Showcase's approach to this partnership included keeping the U.S. Department of Transportation and the Federal Highway Administration informed ***and*** involved throughout the project. FHWA assigned three full-time people to the Showcase project, so keeping them informed was not difficult. We invited the FHWA staff to every project meeting. When the Showcase staff traveled to the vendor sites, the FHWA staff attended. The Policy Committee, with representatives from all of the key Showcase participants-FHWA, FTA, Georgia DOT, MARTA, ITS JPO-provided guidance to the Showcase and met every other month, which helped to keep all affected parties informed and set expectations of final project results. Their involvement in the decision-making process resulted in a strong commitment to the Showcase.

For a partnership to work, the partners must communicate.

The Showcase project recognized the importance of regular communications. With hundreds of activities occurring daily, people need to stay informed. Every Thursday at 2:00 p.m., the management team, the client, and the task managers participated in a conference call which reviewed work, addressed current issues, and evaluated work planned in each area of the project. This meeting allowed the team to deal with issues quickly and to use creative methods for problem solving.

State-of-the-art technology such as e-mail, voice mail, paging, cellular telephones, and video conferencing allowed the bi-coastal Showcase team to maintain daily contact with ease. However, when problems were mounting or when important negotiations were necessary, none of the modem communications methods beat person-to-person meetings. These nose-to-nose encounters were critical for discussions, and equally important, for the camaraderie that kept the project team motivated.

Diversifying the development process makes the project more manageable and reduces risk.

Early in the project, Showcase activities were divided into smaller projects, each with an assigned task manager. The overall Showcase project manager took responsibility for defining a scope of work for each task to ensure that all work would accomplish the overall needs of the program. The Independent Service Providers who developed the personal communications devices, in-vehicle devices, cable television, on-line services, and interactive television worked under individual firm-fixed price contracts. Keeping these development activities separate meant that the failure of one of the devices would not have an impact on the operations of the other devices (e.g., if a PCD system did not work, the other systems would continue to operate without interruption).

However, there were critical all-or-nothing systems for which the core team members, who worked under cost-plus-award fee contracts, were responsible. Surveillance, for example, was a core team function: without surveillance data, the devices could not provide full service. Other core team responsibilities included overall project management, operations management, systems testing and communications support, fixed-end server development, and public relations and outreach.

The project will rely on some things you cannot control.

Developing contingencies for unexpected technical problems helped to make the Showcase project successful. For example, the Showcase planned on using surveillance data from automated technology installed by the Georgia Department of Transportation. However, the surveillance plan included a contingency to address what the project would do if the data were not available. As it turned out, tbe data did not become available until after the Showcase period. The project team transitioned to the contingency plan smoothly and effectively.

Contingencies for budgets and intermediate schedules are also important. The Showcase project plan identified a management reserve of funds to use when changes required more funding, and also identified places in the project where time could be reduced if absolutely necessary. For example, the schedule identified five months for system testing. We knew that the testing could be accomplished in three months but with less rigor, which meant the potential for more bugs remaining to be discovered by users. The project ended up needing the extra two months for development, which saved the schedule with its intended start date.

However, we also knew that there are areas where compromise was not possible. Before any subcontract was written for a participant to join the Showcase team, a clear understanding and mutual acceptance of schedule requirements were established. This project time line could not be delayed-the date for the beginning of the Olympic Games was not going to change, and the Showcase was required to be operational at that time. Everyone understood this, and all decisions were made with this in mind. The end date for an effort such as this can never be a point of negotiation.

Include domain experts whenever possible.

Nothing can beat experience and demonstrated success. The engineers and systems specialists of the Showcase project found much needed support from production specialists, media consultants who knew the regional systems, and FHWA personnel who could provide local area knowledge.

For example, the Showcase team worked hard to develop an automated cable television system that retrieved real-time traffic and incident data from the Showcase fixed-end server and presented it to the public in a television broadcast. The system operated much like a cable television weather channel, with the information focus on transportation. When the project team thought it had completed the development work, we hired a television production advisor to view the programming and make comments. After viewing the transportation program, the advisor recommended that the team completely change the color combinations as well as the programming format. In retrospect, the development team was presenting far too much transportation information on a screen, and the viewer was unable to decipher all that was going on. The project team rewrote the programming script. The lesson learned was to involve the domain experts early in the design work on any program.

Establish a dedicated testing team early in the project.

At the beginning of the effort, the Showcase project assigned a dedicated test team that focused on ensuring the systems worked as designed. While the systems were being developed, the test team participated in project meetings and developed the test plans to be executed. No member of the testing team was involved in developing a device. When testing began, the test team was extremely knowledgeable of what the system should do and was able to begin work immediately. The test team also worked very closely with the development teams to communicate any problems and define resolutions.

The testing team's expertise and knowledge of the system made them a logical member of the operations team. By the time testing was completed, the team had really learned the "ins-and-outs" of all the systems. The test team was retained during the system operation to help run the systems. Many times they expedited fixes that would have taken the operations staff much more time to diagnosis.

During operations, someone must be in charge at all times.

During the operational period of the Showcase, a supervisor was on duty at all times. The supervisor continually viewed the operations of all the ATIS devices and was responsible for ensuring that they were fully operational. When anomalies were discovered, the Showcase supervisor had the ability and the authority to contact the development teams to initiate fixes. Focusing this effort proved to be effective in keeping the systems operational at all times.

Duplicate high risk requirements to mitigate risk.

In order to minimize risk, the Showcase team chose to duplicate the effort needed to ensure that a personal communication device would be available for the scheduled operational period. FHWA had identified the PCD as their number one priority. However, during the planning phases of the program the Showcase team identified several devices, but there was no software. Creating the necessary functionality would require a major software development effort with little available time. This effort was viewed as a major risk. Therefore, the Showcase contracted with two suppliers (Fastline and ETAK/Hewlett Packard) for software development with the objective of having at least one PCD available when needed. Fortunately both suppliers delivered systems which resulted in an enhanced PCD demonstration.

For demonstration projects, leasing can minimize costs.

Establishing offices and providing hardware, software, and other equipment for personnel can be a major expense for a project such as the Showcase. The project required dedicated facilities capable of housing team members involved not only in the development of the Showcase systems but in maintaining the day-to-day operations and media contacts. The Showcase demonstration had a clearly defined lifetime, and the project team found that leasing equipment minimized costs tremendously and also reduced the need for equipment disposal at the end of the program.

Maintain complete and accurate record books of all project activities.

The managers of the Showcase were in contact with nearly 100 organizations during the project. Keeping track of this much information required clearly documented results of ***all*** discussions (meetings, teleconferences, hallway discussions, telephone calls). Maintaining daily records was especially important on this 16-month project. Sometimes people can forget specifics of agreements and other arrangements, and having a bound, dated record book provided a valuable tool for retracing decisions and clarifying reasons for doing the project the way it was done. The records minimized arguments and kept the project focused.

Protect people and company images and reputations.

People will work much better as a team if everyone takes the extra effort to absolutely maintain the image and reputation of all participants. A company that is a member of the team must be treated as an equal partner, with the team working together to resolve issues and problems, not focus attention or assign blame to anyone. The concept of partnership can build goodwill among team members. Showcase management tried to establish a recognized give-and-take relationship with everyone. When we could, we accommodated a team member's particular issues (e.g., functionality or ownership), but we stood firm when any request jeopardized the overall success of the project or had an impact on another person or contractor. This give-and-take relationship was recognized and helped to establish the strong team partnership relationship.

ITS deployments can be accomplished within restrictive time constraints,

The Showcase project showed that ITS deployments can be done in a short time and be successful. The project success was a result of the ability of the team to form a true partnership between the public and private sectors as well as the host of private sector contractors doing the work. The individuals on the team worked hard together toward one common goal and did what was necessary to complete the project successfully. They committed their energy to the Showcase's goal, maintained flexibility in their work, adhered to the prescribed schedules, openly dealt with problems and issues, and treated each other with respect. The result was the first full-scale demonstration of ITS technologies for general public use.

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Glossary of Technical Terms

Glossary of Technical Terms

10 Base -T	a network connection operating at a speed of 1OMbps and using twisted-pair conductors
advanced traffic management systems (ATMS)	also called ATMS; a traffic management center or facility that is augmented with electronic surveillance, video, and computing resources for data processing and graphical information display (as compared to telephones and paper maps)
architecture	the underlying structure or framework of a system (e.g., definition of the hardware standards, operating systems environment, applications software)
ARDIS wireless communications	a wireless **packet** radio system
Autoscope™	a technology that performs image analysis and detection and stores object measurements such as area, perimeter, circularity and eccentricity; device selected by GDOT to perform surveillance on Atlanta freeways
backbone	the supporting infrastructure of a system that enables individual systems to work together (e.g., fiber optics)
bandwidth	in digital data communications, the data capacity of a channel expressed in Hz representing bits per second (e.g., a 1OMHz bandwidth channel has a capacity to exchange data at the rate of 1OMbps)
bug	an error in computer software which causes improper behavior; an error of omission or incorrect logic
call taker	a TMC system operator with responsibility to take calls from the public regarding accidents, incidents, and other traffic information and enter this information into the system to be processed and distributed
client-server architecture	a computing architecture in which both information and control are distributed and shared; in each transaction, two components assume the roles of initiating a request for information (client) and the other of responding to that request for information (server)
confirmed incident	a reported incident verified by an authoritative source, such as a Showcase Surveillance Supervisor, GDOT employee or MetroNetworks. Verification techniques include visual confirmation, reports

from law enforcement, reports from GDOT staff (e.g., maintenance crew) and multiple calls (three or more) on the same incident.

core team — the central group of companies which developed the supporting system infrastructure of the Atlanta Traveler Information Showcase and managed the project; the core team members, led by Battelle, included BRW, JHK & Associates, System Resources Corporation, TRW, and Walcoff & Associates

ethernet — a class of networking media access techniques operating at 1OMHz and employing collision detection and multiple access (IEEE 802.3)

failover mode — a reduced capacity, degraded mode of operation used when one or more system components or subsystems are unable to perform their mission as expected

fiber optic — a flexible glass medium using pulsed laser technology to transport digital data at rates of 1OOMHz or more

field operational test (FOT) — system or component testing performed in an actual operational environment by the actual users/operators

fixed-end server (FES) — a specific server in a **client-server architecture;** fixed repository of information

FM subcarrier — a portion of the commercial FM broadcast band used for transmission of data

gateway — a central device that provides a common entry and exit point and data communications management services to interconnect one network to another

GeorgiaNet — a state authority which disseminates state information to the general public; users may access legislative searches, procurement registry, and state agency information about permits, licenses, registration, etc.

Global Positioning System (GPS) — a government-owned system which consists of 24 deployed satellites transmitting to ground receivers that provides accurate positioning by calculating the exact location (latitude and longitude) of objects on earth

graphical user interface (GUI) — a human-computer interface based on graphical tools, using pointing devices to navigate through task-oriented data entry, information display, and operator-system interaction

hotline — a telephone number which users could access from 7 a.m. to 10 p.m. during the Showcase operational period to receive support from Showcase staff about any of the deployed devices

in-kind contribution — a contribution of something of value (e.g., services, products) as a portion of an overall contract for goods or services; the U.S. DOT required, as a condition of Showcase participation, that each vendor providing an information distribution device contribute some of their own resources (e.g., money, reduced hardware costs, personnel time)

independent service provider — an external client or system that draws information from a one or more context servers, then redistributes that information to a subscriber/ customer base as part of a more complete service (e.g., personal communication device)

integration — the collection and interconnection of multiple components or subsystems to form an aggregate system

Intelligent Transportation System — the application of telecommunications and information and computer technologies to the needs and problems of the U.S. highway, rail, and transit infrastructure. Using sensors, computerized traffic control systems, and electronic navigation, these technologies, many of which were developed for aviation, the space program, and the defense program, are now being deployed to make the movement of people and goods easier, safer, and less polluting

interactive television — cable television with the capability to respond to requests from a controller or keypad, then display information in response to those requests (e.g., such as found in hotel rooms)

Internet — a global network of computers that communicate using a common language

ITS Atlanta — **intelligent transportation systems** in the Atlanta region, including the Georgia Department of Transportation's Atlanta Traffic Management System, the Traveler Information **Kiosk** developed by GDOT and JHK & Associates, the Atlanta Driver Advisory System (ADAS) **Field Operational Test,** ITS MARTA '96, and the Traveler Information Showcase

kiosk — a public user information terminal, providing interactive access to travel information such as public transportation routes and schedules, shuttle services, restaurant locations, and other information for travelers

legacy operations — an established goal of the Traveler Information Showcase to continue the operation of as many of the ITS systems as possible after the "Showcase" period (e.g., after September 30, 1996)

map database	a database of data elements and relationships which represent the information needed to display a map
MARTA	the public transit system for the Atlanta, Georgia metropolitan area operating over 700 buses and 240 rail cars. MARTA was the exclusive public provider of spectator transportation for the 1996 Olympic Games.
Olympic Games Park and Ride Lot	a designated parking area for Olympic Games spectators
Operational mode A	in Mode "A" the ATMS controls all TIS surveillance sites and acquires all radar surveillance speed data; also acquires speed data from Autoscopes™
Operational mode B	in Mode "B" the TIS controls all TIS surveillance sites and acquires all radar surveillance speed data; no control or acquisition of data from other surveillance assets
Operations Manager	manager of the TMC operations crew who was responsible for efficient, effective, and proper operation of the system, data collection and entry, and operations and maintenance of the system
packets	a discrete data transport container with a data segment payload (the data), and destination- and origin-addressing information for use by the communications system
PeachNet	an Internet service provider in the Atlanta, Georgia region
Personal Communications Device	a pocket-sized, hand-held or portable computer serving as a communications terminal for electronic mail, send/receive faxes, etc.
POT lines	"plain old telephone lines," voice grade, acceptable for transmission of analog signals in range 0-3KHz
PTZ	the pan-tilt-zoom control of a remote video camera: pan (move left or right), tilt (move up or down), zoom (move view closer in or farther out)
public-private partnership	a team comprising public (e.g., federal, state, local government) and private (e.g., commercial businesses) entities working together for a common goal; funding for the work comes from the government source and the private sector (through in-kind contributions)
serial connection	a data connection which transfers the information content one bit after another

slow scan video	video system producing images at much slower rate than normal full-motion video with appearance of multiple still images and suitable for digital transmission over voice grade (e.g., telephone) lines
surveillance supervisor	supervisor/manager of surveillance resources; responsible for monitoring the surveillance system, providing direction to Showcase call-takers for checking and resolving data inconsistencies, collecting information from ACOG on park and ride lots, supervising mobile spotters, and supervising Metro Networks' surveillance activities
venue	a site for an Olympic or Paralympic event (e.g., Olympic Stadium, Georgia Dome, Stone Mountain Archery/Cycling Complex)
Web server	a host server connected to the Internet as the repository for one or more "Home Pages" and the related information or services provided by that Home Page/web site
World Wide Web	a Internet-based network that allows users on one computer to access and view information stored on another through the world wide network
x-terminal	a simplified or reduced capacity device used as an interface terminal to a multi-user UNIX system running the "X' graphical user interface

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