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# Guidance for Developing and Deploying Real-time Traveler Information Systems for Transit

April 2003

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The advent of automatic vehicle location systems not only has provided the transit industry with tools to monitor and control operations, but with the opportunity to provide customers with real-time information. This real-time information enables existing and potential riders to make better pre-trip and en-route decisions. Providing real-time information has additional benefits to the transit agency: improving customer service; increasing customer satisfaction and convenience; maintaining or increasing ridership; and improving visibility of transit in the community. This document offers guidance for transit agencies that are considering the deployment of real-time transit information systems. An understanding of the current state of the practice in these systems is presented, along with information on the components of successful systems, issues and challenges that must be addressed in deployment, recommended practices for successful deployment, and a description of the future of these systems.

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# List of Acronyms

| | |
|---|---|
| ADA | Americans with Disabilities Act |
| ASP | application service provider |
| ATIS | advanced traveler information system |
| AVL | automatic vehicle location |
| BRT | bus rapid transit |
| CDPD | cellular digital packet data |
| COTS | commercial-off-the-shelf |
| CR | commuter rail |
| CSC | customer service center |
| CUE | City-University-Energysaver |
| DMS | dynamic message sign |
| EDAPTS | Efficient Development of Advanced Public Transportation Systems |
| ETA | estimated time of arrival |
| FTA | Federal Transit Administration |
| GPS | global positioning system |
| HR | heavy rail |
| HTML | Hypertext Markup Language |
| ISDN | integrated services digital network |
| ITS | intelligent transportation systems |
| IVR | interactive voice response |
| LCD | liquid crystal display |
| LED | light-emitting diode |
| LR | light rail |
| MDT | mobile data terminal |
| MMDI | Metropolitan Model Deployment Initiative |
| O&M | operations and maintenance |
| PA | public address |
| PCD | personal communication device |
| PDA | personal digital assistant |
| PIDS | passenger information display system |

| | |
|---|---|
| RFP | request for proposal |
| Tri-Met | Tri-County Metropolitan Transportation District of Oregon |
| Tri-Rail | Tri-County Commuter Rail Authority |
| TRB | Transportation Research Board |
| TCRP | Transit Cooperative Research Program |
| TIS | transit information system |
| TPP | time point propagation |
| TTS | text to speech |
| WAP | Wireless Application Protocol |
| WML | Wireless Markup Language |
| XML | Extensible Markup Language |

# Foreword and Disclaimer / Notice

The *Guidance for Developing and Deploying Real-time Traveler Information Systems for Transit* document provides key information about the current state of practice. This document includes information about system components and offers lessons learned and recommended practices for successful deployments. The document is intended for transit agencies that are considering the deployment of real-time transit information systems.

This is the final version of this document, and it does not supersede any previous publications.

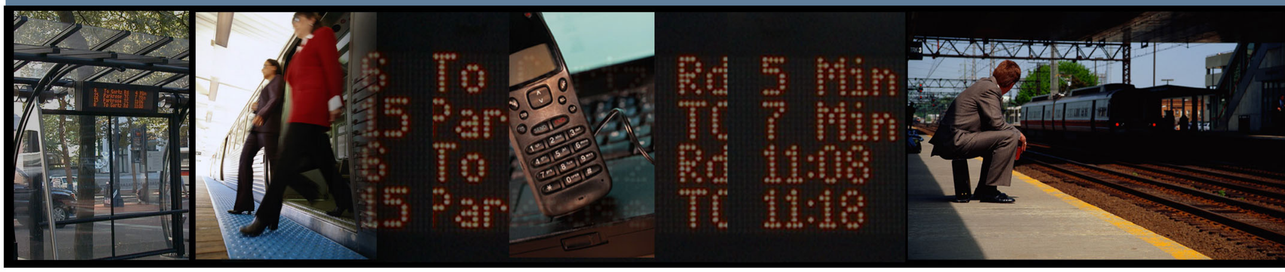
# Preface / Acknowledgments

The Federal Transit Administration's Office of Research, Demonstration, and Innovation sponsored and managed the Guidance for Developing and Deploying Real-time Traveler Information Systems for Transit project. The U.S. Department of Transportation, Intelligent Transportation Systems, Joint Program Office provided funding for the research. FTA would like to acknowledge the exceptional contributions of the participating transit agencies that provided the information for this resource document:

- San Francisco Municipal Railway (MUNI)
- Denver Regional Transportation District (RTD)
- King County MetroTransit
- Tri-County Metropolitan Transportation District of Oregon (Tri-Met)
- Tri-County Commuter Rail Authority (Tri-Rail)
- Cape Cod Regional Transit Authority (CCRTA)
- Washington Metropolitan Area Transit Authority (WMATA)
- Virginia Railway Express (VRE)
- Fairfax City-University-EnergySaver (CUE)
- Washington State Ferries (WSF)
- San Luis Obispo Transit (SLO Transit)
- Los Angeles Department of Transportation (LADOT)/Los Angeles Metropolitan Transportation Authority (LAMTA)
- Jacksonville Transportation Authority (JTA)
- River Valley Transit (formerly City Bus)
- Chicago METRA (Commuter Rail)
- Chicago Regional Transportation Authority (RTA).

Brian Cronin managed the project under the support and direction of FTA's administration:

- Jennifer L. Dorn (Administrator)
- Barbara A. Sisson (Associate Administrator, Office of Research, Demonstration, and Innovation)
- Ronald Boenau (Office of Research, Demonstration and Innovation)
- Walter Kulyk (Director, Office of Mobility Innovation).



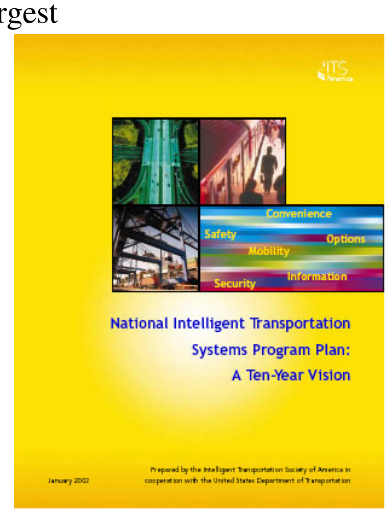

# Executive Summary

Transit customers today want and expect reliable, up-to-date, information from their local transit agencies. Reliable information assists the rider in making their transit and multimodal trip plans. Providing high quality information on transit status information has shown to improve customer service, which in turn can lead to increased ridership.

The advent of automatic vehicle location (AVL) systems not only has provided the transit industry with tools to monitor and control operations, but with the opportunity to provide customers with real-time information. This real-time information enables existing and potential riders to make better pre-trip and en-route decisions. Providing real-time information has additional benefits to the transit agency: improving customer service; increasing customer satisfaction and convenience; maintaining or increasing ridership; and improving visibility of transit in the community.

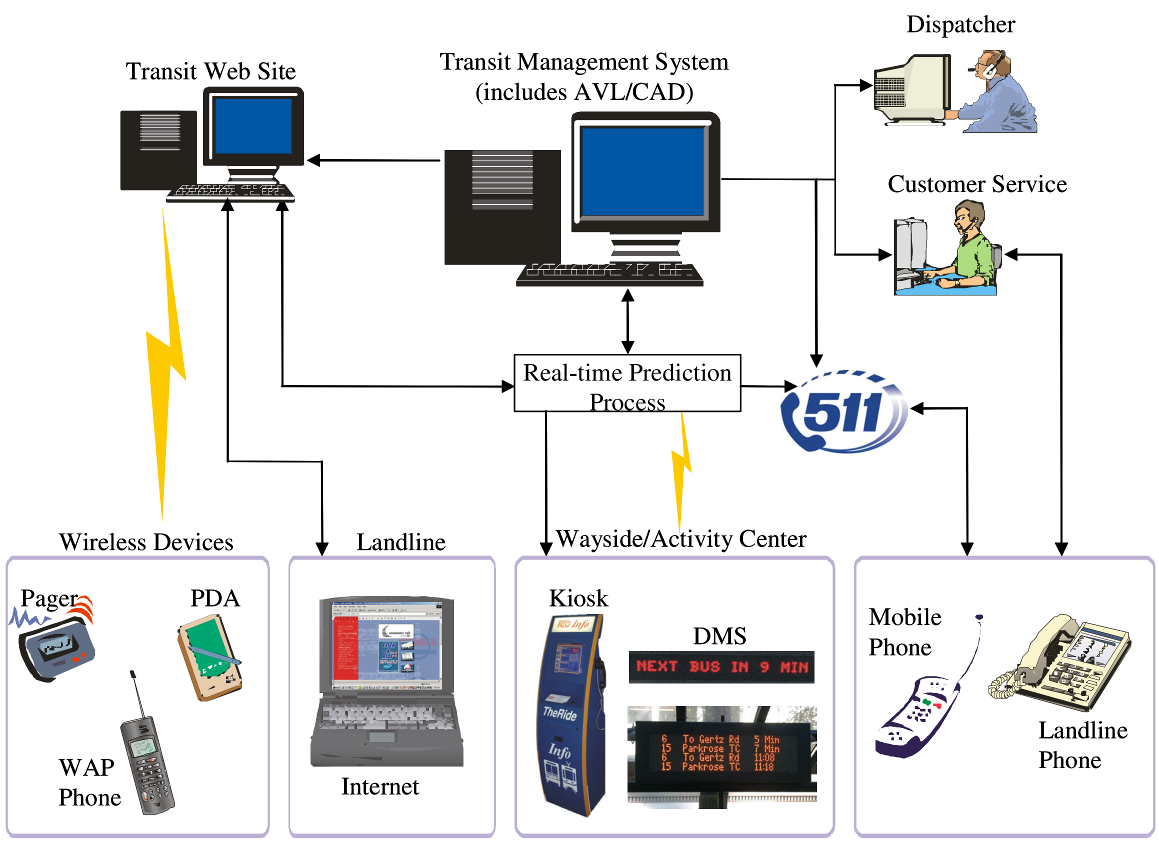
**Real-time transit information systems contribute to world-class public transportation, ensure transit awareness, and are an integral part of livable and thriving communities.**

The Intelligent Transportation Systems Deployment Tracking survey, which collects information on progress being made toward achieving U.S. Department of Transportation's goal of deploying ITS infrastructure in the nation's largest metropolitan areas by 2005, continues to show increases in the planning and implementation of real-time transit information systems. During ITS America's 10-Year Vision planning session workshops in late 2001, the transit industry requested that FTA provide guidance information on traveler information systems. Specifically, as real-time arrival systems were being planned and implemented, best practice information was requested by the industry. This Guidance document effort was initiated in response to the industry's request.




This Guidance document provides key information for transit agencies that are considering the deployment of real-time transit information systems. An understanding of the current state of the practice in these systems is presented, along with information on the components of successful systems, issues and challenges that must be addressed in deployment, recommended practices for successful deployment, and a description of the future of these systems.

The figure shown below depicts a high-level view of a real-time transit information system. As the figure shows, the traveling public accesses the system for real-time transit information. For example, users may access a web site that provides schedule information or view an electronic sign that gives the next bus arrival time. Underlying these aspects of the system is the "engine," which is usually integrated with a transit management system. For example, in order to project vehicle arrival time, an automatic vehicle location (AVL) system is necessary to provide the real-time vehicle location data. Then, the real-time traveler information system uses the current vehicle location to compute the estimated arrival time at the upstream stops using data that may include vehicle speed, distance, travel time history, and traffic flow history. Many applications use a countdown to the arrival of the next vehicle (e.g., next bus in 5 minutes) rather than an estimated arrival time.



The distribution of real-time transit information takes many forms. At transit facilities and other key locations (e.g., activity centers), estimated arrival time of the next vehicle is provided on electronic signs (also known as dynamic message signs [DMSs]), as well as other public information devices, such as interactive kiosks. Riders with access to the Internet can obtain real-time transit information, as well as static and general transit information (e.g., schedule and fare) from a transit agency's web site. Increasingly, real-time transit information is bundled with other travel- or transportation-related information available from third-party web sites. Riders with personal communications devices (PCD) such as a pager, a wireless application protocol (WAP)-enabled cell phone, or a wireless personal digital assistant (PDA), can acquire real-time transit information from anywhere there is wireless communication coverage.

Primary hardware and software features of a successful real-time transit information system are identified in this report. The hardware features include dynamic message signs, wireless media applications, automatic vehicle location systems, and communication systems. The software features include prediction of real-time information, Internet and e-mail applications, interactive voice response, mobile real-time application software, and communications software.

The issues and challenges transit agencies face when implementing real-time information systems were discussed with agencies that have deployed these systems. The agencies noted issues and challenges in the areas of planning, funding, technical expertise and staff, communications costs, prediction algorithms, and data accuracy.

Key issues and challenges in these areas are highlighted below:

- **Planning.** Lack of a proper definition of the goals, objectives and requirements of the real-time system, which may limit the functionality and expandability of the system, and future integration with other systems.

- **Funding.** Availability of sufficient funds to procure, implement, operate, and maintain a sophisticated real-time transit information system.

- **Technical Expertise and Staff.** Availability and technical capability of staff within the agency to deal with the new technology, and having personnel dedicated to managing the data.

- **Communications.** Communication costs to relay real-time transit information to media such as dynamic message signs.

- **Proprietary Prediction Algorithm**. Challenges in getting algorithms; ownership of the system and the data; the recurring operations and maintenance costs incurred by the agency; and negotiation and payment to their existing AVL vendor to develop the real-time traveler information system prediction algorithm.

- **Accuracy of Data.** Uniquely identified bus stops and the accuracy of AVL data, which in turn affects the accuracy of the predicted arrival and departure times.

Recommended practices leading to the most innovative and successful deployments of real-time transit information systems are described in detail in the guidance. Recommended practices include the following:

- **Planning**. Involving relevant departments and stakeholders, and planning for communication cost and provision of power to wayside equipment.

- **Procurement**. Sound procurement procedures and policies to reduce complications and problems, and ensuring that the planned system meets the requirements that were set forth in the planning stage.

- **Implementation**. Adhering to comprehensive implementation procedures and processes; conducting phased implementations; using prediction algorithms that yield accurate information; and defining infrastructure requirements.

- **Operations and Maintenance**. Addressing the system's ongoing O&M needs, such as providing training, maintaining the system, ensuring adequate staff and other resource needs, monitoring the system and the data, and updating inputs (i.e., schedules and stop locations).

- **Marketing.** Providing customers with information about the availability of real-time information on each dissemination media.

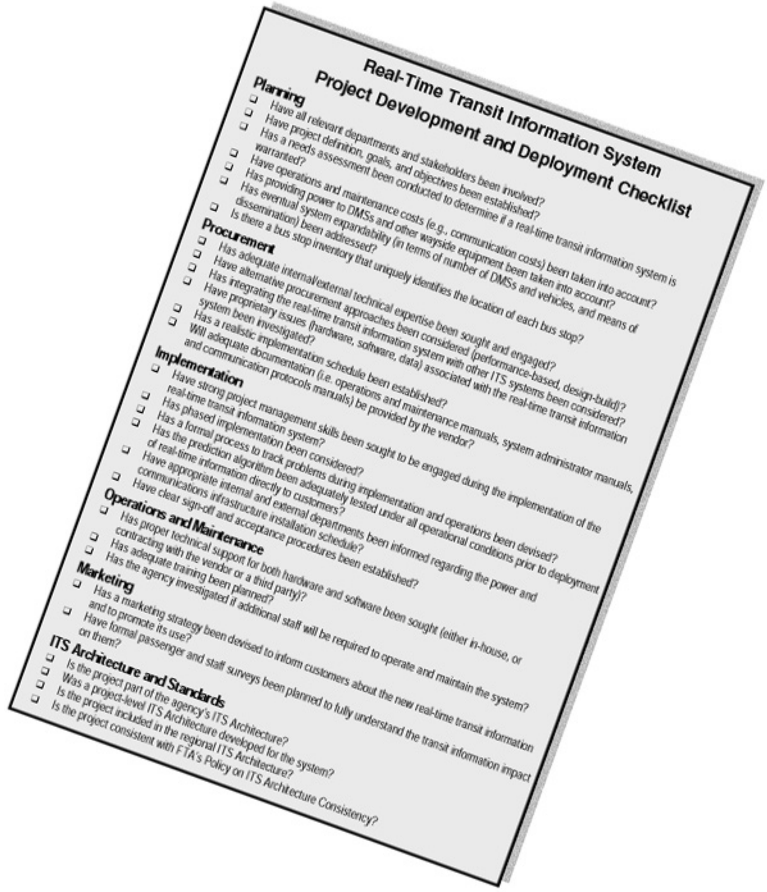
- **Business Models.** Using an information services business model, such as a vendor providing a real-time information service, rather than selling the infrastructure to an agency for the agency to operate, or a vendor that uses transit agency generated data to alert customers about real-time information.

- **National ITS Architecture and Standards**. At a minimum, identifying how the proposed real-time traveler information system "fits into" a regional ITS architecture; which pieces or services of that architecture the agency is providing; and which (if any) ITS standards are applicable for your system and which will be used/implemented.

The guidance document includes a checklist to highlight the factors associated with developing and deploying a real-time transit information system.

The deployment of real-time traveler information systems in the United States is growing rapidly. In the future, two changes in the industry will support the continued successful deployment of these systems. First, few applicable data and communications standards have been tested and none have been formally adopted by USDOT. Moving these standards forward will ensure that as transit agencies design, deploy, and operate these systems, the use of these standards will simplify the deployment and provide a measure of consistency and interoperability among different transit ITS applications.

Second, advances in technology applications and in the transit industry will have an impact on the deployment of these systems. The technology is migrating toward the use of extensible mark-up language (XML) and the Internet as the "backbone" of many of the systems. Penetration of mobile telephones, hand-held personal digital assistants, and other wireless communication devices continue to change the way travelers interact with their surroundings. Continued improvements in these technologies (faster communication, better coverage, greater capability to handle video and pictures.) will drive the real-time traveler information applications of the future.



**Real-Time Transit Information System**
**Project Development and Deployment Checklist**

**Planning**
- Have all relevant departments and stakeholders been involved?
- Have project definition, goals, and objectives been established?
- Has a needs assessment been conducted to determine if a real-time transit information system is warranted?
- Have operations and maintenance costs (e.g., communication costs) been taken into account?
- Has providing power to DMSs and other wayside equipment been taken into account?
- Has eventual system expandability (in terms of number of DMSs and vehicles, and means of dissemination) been addressed?
- Is there a bus stop inventory that uniquely identifies the location of each bus stop?

**Procurement**
- Has adequate internal/external technical expertise been sought and engaged?
- Have alternative procurement approaches been considered (performance-based, design-build)?
- Has integrating the real-time transit information system with other ITS systems been considered?
- Have proprietary issues (hardware, software, data) associated with the real-time transit information system been investigated?
- Has a realistic implementation schedule been established?
- Will adequate documentation (i.e. operations and maintenance manuals, system administrator manuals, and communication protocols manuals) be provided by the vendor?

**Implementation**
- Have strong project management skills been sought to be engaged during the implementation of the real-time transit information system?
- Has phased implementation been considered?
- Has a formal process to track problems during implementation and operations been devised?
- Has the prediction algorithm been adequately tested under all operational conditions prior to deployment of real-time information directly to customers?
- Have appropriate internal and external departments been informed regarding the power and communications infrastructure installation schedule?
- Have clear sign-off and acceptance procedures been established?

**Operations and Maintenance**
- Has proper technical support for both hardware and software been sought (either in-house, or contracting with the vendor or a third party)?
- Has adequate training been planned?
- Has the agency investigated if additional staff will be required to operate and maintain the system?

**Marketing**
- Has a marketing strategy been devised to inform customers about the new real-time transit information and to promote its use?
- Have formal passenger and staff surveys been planned to fully understand the transit information impact on them?

**ITS Architecture and Standards**
- Is the project part of the agency's ITS Architecture?
- Was a project-level ITS Architecture developed for the system?
- Is the project included in the regional ITS Architecture?
- Is the project consistent with FTA's Policy on ITS Architecture Consistency?

Further, the stronger emphasis on customer-oriented services and on attracting choice riders will influence agencies that are considering technology deployment to make real-time transit information systems a priority. Finally, many regions will consider and deploy real-time transit information integrated with other traveler information. With the advent of 511 and Internet-based traveler information systems, customers seeking multimodal information are interested in "one-stop shopping." Real-time transit information will undoubtedly add value to regional traveler information, and will potentially influence travelers to consider transit who previously may not have considered it as an alternative.

**Emphasis on customer-oriented services will make real-time transit information systems a priority.**

# Introduction 1

Real-time transit information systems provide timely and accurate information to current and potential riders to enable them to make better pre-trip and en-route decisions. The most frequently provided real-time transit information includes vehicle arrival times, and service disruptions and delays.

While the part of real-time traveler information systems accessed and used by the traveling public is often relatively simple (e.g., a sign giving the next bus arrival time), the "system" behind what the user sees can be rather complex. Real-time traveler information systems are typically integrated with transit management systems, as shown in Figure 1-1. For example, in order to project vehicle arrival time, an automatic vehicle location (AVL) system is necessary to provide the real-time vehicle location data. The real-time traveler information system then uses the current vehicle location to compute the estimated arrival time at the upstream stops using data that may include vehicle speed, distance, travel time history, and traffic flow history. In many applications, a countdown to the arrival of the next vehicle (e.g., next bus in 5 minutes) is used rather than an estimated arrival time.

The distribution of real-time transit information takes many forms. At transit facilities and other key locations (e.g., activity centers), estimated arrival time of the next vehicle is provided on electronic signs (also known as dynamic message signs [DMSs]), as well as other public information devices, such as interactive kiosks. Kiosks, which differ from the electronic signs, allow a user to query information of interest from data stored in the kiosk or from a database that resides in the main computer server that drives the system. Sometimes kiosks are connected to the transit agency's web site and act as an interface to the web site to retrieve and provide real-time transit information.

**The distribution of real-time transit information takes many forms:**
- Activity centers
- Dynamic message signs
- Interactive kiosks

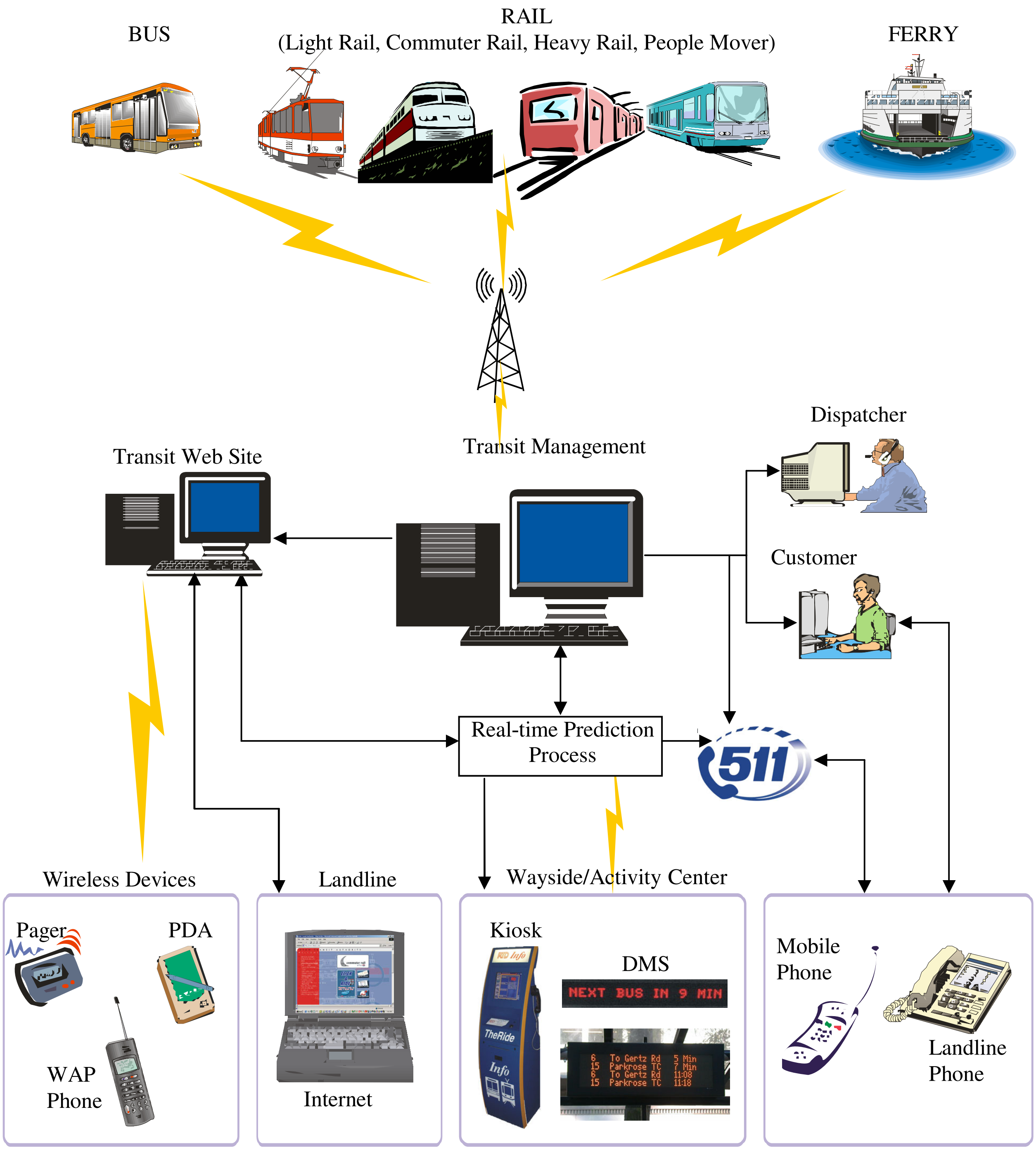



**Figure 1-1. Real-Time Transit Information Systems are Typically Integrated with the Transit Management System**

Riders with access to the Internet can obtain real-time transit information as well as static and general transit information (e.g., schedule and fare) from a transit agency's web site. Increasingly, real-time transit information is bundled with other travel or transportation-related information available from third-party web sites (e.g., MyTrafficNews.com, which displays real-time transit information from the Denver Regional Transportation District).

Riders with a personal communications device (PCD) such as a pager, a Wireless Application Protocol (WAP)-enabled cell phone, or a wireless personal digital assistant (PDA), can acquire real-time transit information if there is wireless communication coverage.

Real-time transit information also greatly enhances customer service through conventional telephone lines. Call centers operated by many transit agencies experience high daily call volumes. The availability of real-time transit information allows customer service representatives to respond better to service-related inquiries and complaints. Availability of real-time information also often reduces the call volumes.

Recently, the U.S. Department of Transportation (DOT) launched an initiative to promote deployment of a national telephone number (511) that provides regional transportation-related information. The Federal Communications Commission provided the 511 number. States and metro areas will be able to implement the traveler information number, which includes public transit information, but to date (December 2002), most transit information provided on 511 is schedule, not real-time information. U.S. DOT envisions that the 511 interactive telephone services eventually will provide real-time transit information, such as estimated arrival and departure times, and service changes or disruptions.

Customer surveys and other real-time traveler information systems-related literature document the many benefits resulting from the deployment of real-time traveler information systems. Among the reported benefits are the following:

- Customers perceive that the waiting time at a stop/station with real-time bus arrival information is reduced, and therefore, waiting is more acceptable
- Customers perceive that the transit service has improved and become more reliable (even if it has not, in reality, changed)
- Customers perceive that their safety and security is improved when waiting at a stop with real-time information
- General attitudes toward transit have improved when real-time information is provided
- Customers will wait at a stop/station where real-time information is provided, when they may not have done so ordinarily

- Ridership and revenues can be expected to increase
- A modal shift toward public transportation could result from the deployment of real-time traveler information systems.

The most significant benefit of real-time traveler information systems reported by agencies is improved customer service, with increased customer satisfaction as the second greatest benefit. The next most important benefits are as follows:

**Real-time traveler information systems significantly improve customer service and satisfaction.**

- Improved visibility of transit in the community
- Ability to monitor vehicle operations
- Increased customer convenience
- Increased ridership
- Improved ability to react to service delays
- Improved reliability of trip travel times.

## 1.1 Background

Part of FTA's mission is to provide "…technical assistance and financial resources for safe, technologically advanced public transportation which enhances all citizens' mobility and accessibility." FTA has further defined five strategic goals to focus their efforts in fulfilling this mission:

- Safety and Security
- Mobility and Accessibility
- Economic Growth and Trade
- Human and Natural Environment
- Quality Organization.

Assisting transit agencies in providing accurate and reliable real-time transit information is a key component in FTA's efforts to achieve its Mobility and Accessibility strategic goal. Providing real-time transit information will help improve the public's access to transit, improve operational efficiencies, and, in combination with other static information services, enhance customers' flexibility of choice by providing information on the types, locations, and costs of services offered.

Although every transit agency provides some type of information to their riders, today's customers are expecting more and better information. In order to address these demands, some transit agencies have implemented systems to provide real-time traveler information about vehicle location, estimated arrival times, and on-board announcements. Since these systems have shown some success, wide-scale deployment among the transit community is just beginning to occur.

## 1.2 Scope of the Project

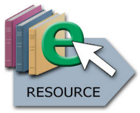
In May 2002, the Federal Transit Administration (FTA) initiated a project that resulted in the development of this guidance document detailing information on the implementation of real-time transit information systems for all modes of transit in the United States. FTA intends this guidance document to provide relevant and practical information about the planning, procurement, implementation, operations and maintenance, and marketing practices of successfully implemented real-time traveler information systems. The successful deployments of real-time traveler information systems in the United States offer many lessons learned for transit agencies that are considering similar systems to enhance ridership and provide transit travelers with up-to-the minute real-time information.

This document is a resource, providing information to guide transit agencies in addressing common issues and challenges that may arise when deploying real-time traveler information systems. This document is not a "how to" manual, and does not recommend vendors or systems. However, this document will provide insights to transit agencies interested in evaluating best practices and learning from the experiences of other organizations.

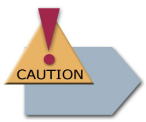
## 1.3 How This Document is Organized

This document is designed for use by a transit agency that is considering the implementation of a real-time traveler information system. It is organized to help the reader understand the current state of the practice with respect to the deployment and operation of real-time traveler information systems in transit. The reader is guided through a discussion of major components of a successful system. This information is followed by a discussion of the issues and challenges transit agencies can expect to encounter when designing, deploying, and operating real-time traveler information systems, and concludes with the identification of recommended practices.

In order to assist the reader in understanding and using the information provided in this guidance document, several icons are used throughout the document to highlight specific topics.




**Resource** – This icon indicates references to other useful resources the transit agency may want to consult while implementing its real-time traveler information system.




**Caution** – This icon indicates "lessons learned" or cautionary advice to the implementer of a real-time traveler information system. Some agencies around the United States have already implemented transit traveler information systems and this icon identifies issues and/or problems they have faced.


**Checklist Item** – Section 5 includes a checklist for implementing real-time traveler information systems. The checklist is intended for use as a "memory jogger" or "quick guide" during project discussions to ensure the agency has addressed all areas of concern.


**Recommended Practice** – Throughout the document, suggestions are provided for those considering deployment and operation of real-time traveler information systems. This icon indicates recommendations based on the real-world, hands-on experiences of other transit agencies that have been down the road of project implementation, and offers the reader the opportunity to learn from others' experiences.


**Unique Application** – This icon identifies transit agencies or private service providers that have come up with unique or creative applications of technologies to improve the delivery of real-time traveler information in the transit environment.

# Understanding Current Real-Time Traveler Information Systems Deployments

2

This document was developed using a three-pronged approach to collect information: searching and reviewing existing literature on the subject; conducting telephone interviews and site visits; and coordinating with other research efforts. Figure 2-1 illustrates these three activities.


**Figure 2-1. A Three-Pronged Approach was Used to Develop the Guidance Document**

## 2.1 Literature Review

The project began with a review of literature on the implementation of real-time traveler information systems in the United States and abroad, which was summarized in a white paper[1]. The review focused on literature that addressed implementations, operations, dissemination techniques, and issues and problems

[1] "Literature Search and Review of Current Practices in Providing Real-time Transit Information," Battelle and Multisystems, Contract DTFT60-99-D-41022, August 2002.

related to real-time traveler information systems. The following sources provided relevant literature published from 1997 through 2002:

- Transportation Research Information Services (http://ntl.bts.gov), the U.S. DOT's Electronic Document Library (EDL), and the ITS Deployment Tracking web site (http://itsdeployment2.ed.ornl.gov/its2000/default.asp).
- Proceedings of the following conferences:
  - Intelligent Transportation Systems (ITS) World Congress annual meetings
  - ITS America annual meetings
  - American Public Transportation Association (APTA) conferences
  - Transportation Research Board (TRB) annual meetings
- Real-time transit information web sites in the United States and abroad.

RESOURCE

Of the 300 documents reviewed, 53 were directly relevant to real-time traveler information systems. The following information was collected:

- Types of real-time information provided
- Types of media used for dissemination
- Issues and problems related to planning, implementation, and operations of real-time transit information systems
- Techniques for data collection, fusion, and dissemination
- Business models
- Use of National ITS Architecture and ITS Standards
- Customer and/or media reaction
- Agency staff reaction
- Institutional and organizational issues.

Although many of the articles addressed various aspects of real-time traveler information systems related to bus services, little documentation exists on rail systems. In addition, the literature does not provide significant discussions on the use of the National ITS Architecture and ITS Standards in the development of real-time traveler information systems. The requirement for consistency with the National ITS Architecture became effective in April 2001, which may be the reason for the lack of literature about the architecture and standards.

## 2.2 Site Visits and Telephone Interviews of Selected Transit Properties

To enhance the information collected from the literature review and to gain practical knowledge from the implementers of real-time traveler information systems, six site visits and ten telephone interviews were conducted during Fall 2002.

FTA selected these 16 agencies because they had implemented real-time traveler information systems, and in some cases, they were leaders in that area. The selected agencies also represent all modes of transit (bus, rail, and ferry) as well as various sizes (small, medium, and large). The selection illustrates the range of experiences and opinions among these leaders, but in no way is a comprehensive sample of operational real-time traveler information systems in the United States. Based on recent statistics (APTS Deployment Year 2000 Update, May 2002, Table 1-14), there are currently 16 transit agencies that have operational multi-modal traveler information systems and 25 transit agencies that have planned multimodal traveler information systems in the areas outside of the 78 largest U.S. metropolitan cities. Appendix A identifies the participating agencies.

The collected data were synthesized into site summary reports (shown in Appendix B), which include the following information about each agency:

- Transit agency name
- Real-time transit information system name(s)
- Description of the system deployed
- Types of information provided (current and planned)
- Types of media used (current and planned)
- Data collected, processed, and distributed
- Planning, operations, and maintenance
- Architecture and standards
- Business models, marketing, and selling
- Testing, customer satisfaction, and evaluation
- Other general comments.

The telephone interviews and site visits provided practical and useful information from the transit agencies. Table 2-1 summarizes the characteristics of the agencies and provides a brief description of the real-time traveler information system implementations.

**Table 2-1. Telephone Interview and Site Visit Summaries**

| Transit Agency | Location | Modes on which RTTIS is Deployed | Total Number of Vehicles | Number of Vehicles Equipped with AVL | Types of RT Information | Types of Media Used |
|---|---|---|---|---|---|---|
| San Francisco Municipal Railway (MUNI) | San Francisco, California | Light Rail (LR)<br>Buses (B) | 172 LR<br>829 B | 136 LR<br>All revenue buses and 60 non-revenue will be outfitted in the near future | • Arrival Time<br>• Date and Time<br>• Route/Line Number<br>• Audio Announcement (rail stations) | • Internet<br>• DMSs<br>• Kiosks (planned) |
| Denver Regional Transportation District (RTD) | Denver, Colorado | LR<br>B | 31 LR<br>1111 B | 31 LR<br>1111 B | • Estimated Time of Arrival (ETA)<br>• Departure time at end of line and layovers<br>• Route Number<br>• Date and Time | • Internet<br>• Telephone<br>• Kiosks<br>• PDAs<br>• WAP Phones<br>• DMSs (demonstration project) |
| King County MetroTransit | Seattle, Washington | B | 1250 B | 1250 B | • Scheduled Time<br>• Planned Arrival<br>• Depart Status<br>• Route Number<br>• Time | • Internet<br>• Video Monitors<br>• PDAs<br>• WAP Phones<br>• DMS (planned for BRT route) |
| Tri-County Metropolitan Transportation District of Oregon (Tri-Met) | Portland, Oregon | LR<br>B | 78 LR<br>750 B | 78 LR<br>750 B | • Arrival Time<br>• Departure Time (for end of the line)<br>• Date and Time<br>• Route Number<br>• Audio Announcement (Planned) | • DMSs (29 Rail and 11 Bus)<br>• Internet<br>• Kiosks (Planned)<br>• Video Monitors (planned)<br>• WAP Phones (Planned)<br>• PDAs (Planned) |
| Tri-County Commuter Rail Authority (Tri-Rail) | Pompano Beach, Florida | Commuter Rail (CR) | 26 Cars/Cabs<br>10 Locomotives | 11 Cars/Cabs | • Arrival Time<br>• Departure Time (for end of the line)<br>• Delays | • DMSs<br>• Internet |
| Cape Cod Regional Transit Authority (CCRTA) | Cape Cod, Massachusetts | B | 20 B | 20 B | • Location on a map<br>• Route Number<br>• Time | • Internet<br>• DMSs (Planned) |
| Washington Metropolitan Area Transit Authority (WMATA) | Washington, D.C. | Heavy Rail (HR) | 758 Rail Cars | 758 Rail Cars | • Arrival Time<br>• Route Name<br>• Destination<br>• Number of cars in train<br>• Time | • DMSs (437) |

**Table 2-1. Telephone Interview and Site Visit Summaries (continued)**

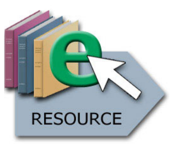
| Transit Agency | Location | Modes on which RTTIS is Deployed | Total Number of Vehicles | Number of Vehicles Equipped with AVL | Types of RT Information | Types of Media Used |
|---|---|---|---|---|---|---|
| Virginia Railway Express (VRE) | Alexandria, Virginia | CR | 72 Rail Cars | 72 Rail Cars | • Location of Train<br>• Delay<br>• Audio Announcements at Stations | • Internet<br>• Phone |
| Fairfax City-University-Energysaver (CUE) | Fairfax, Virginia | B | 12 B | 12 B | • Arrival Time<br>• Route Name<br>• Time<br>• Delay<br>• Location on a map | • DMSs (6)<br>• Internet |
| Washington State Ferries (WSF) | Seattle, Washington | Ferries | 29 | 29 | • Location on a map<br>• Route Name<br>• Time | • Internet |
| San Luis Obispo Transit (SLO Transit) | San Luis Obispo, California | B | 20 | 18 | • Arrival Time<br>• Route Name<br>• Delay | • DMSs |
| Los Angeles Department of Transportation (LADOT)/Los Angeles County Metropolitan Transportation Authority (LAMTA) | Los Angeles, California | Metro Rapid Buses | 150 | 150 | • Arrival Time<br>• Location on a map<br>• Route Name<br>• Time<br>• Delay | • DMSs (44) |
| Jacksonville Transportation Authority (JTA) | Jacksonville, Florida | CR | 9 | 9 | • Arrival Time<br>• Route Name<br>• Date and Time<br>• Audio Announcement | • DMSs |
| River Valley Transit (formerly City Bus) | Williamsport, Pennsylvania | B | 28 | 28 | • Departure Information and Bay Status at downtown transfer location | • DMSs |
| Chicago METRA (Commuter Rail) | Chicago, Illinois | CR | 261 Rail Cars | 261 Rail Cars | • Delay Status over PA | • Public Address (PA)<br>• DMSs (Planned) |
| Chicago Regional Transportation Authority (RTA)[2] | Chicago, Illinois | Chicago Transit Authority (CTA) HR | 1192 Rail Cars and 143 Stations | 4 Stations | • Arrival/Departure Time<br>• Date and Time<br>• Route/Line<br>• Highway Information(only for signs at airport) | • DMSs (4 Pilot) |

[2] RTA does not operate any service. They oversee the three service boards (Chicago Transit Authority, Metra, and Pace) in the greater Chicago metropolitan area.

## 2.3 Coordination with Other Related Efforts

The FTA and the TRB conducted related projects during the development of this guidance document. These projects were reviewed and relevant information was incorporated into this document. The following describes the primary projects considered.

The Transit Cooperative Research Program (TCRP) Project J-7, Synthesis Topic SA-14 - Real Time Bus Arrival Information Systems documents the state of the practice in real-time bus arrival information systems, including both U.S. and international experience. This project includes a review of the relevant literature, in addition to presenting the results of a survey conducted as part of this project. This survey included items describing the systems' technical capabilities, agency experience, cost, and bus rider reactions to these information systems. This synthesis also contains the results of interviews with key personnel at agencies that have implemented, or are in the process of implementing, these systems. A Draft Final Synthesis Report was prepared in January 2003, and provided significant information for this project.




The second project, which is sponsored by the FTA, is entitled Advanced Traveler Information Systems (ATIS) Human Factors Assessment. This project, which was in progress as of March 2003, is determining the following:

- Transit information that travelers want, including the type of information and message content
- Preferred communications channels (media and devices) by which to provide the information
- Preferred locations at which to provide the information
- Preferred temporal and situational aspects of the information (when to provide the transit information)
- Impact of unreliable information
- Recommended design characteristics for effectively presenting transit information via the preferred communications channels.

The final product of this project will be guidance to transit agencies on providing transit information to the public via advanced technology in the most effective and preferred manner from the customer's perspective. As of March 2003, the project team has held workshops around the country to determine the needs, attitudes, and preferences of transit users and non-users for transit traveler information. The final report is expected to be available in Summer/Fall 2003.

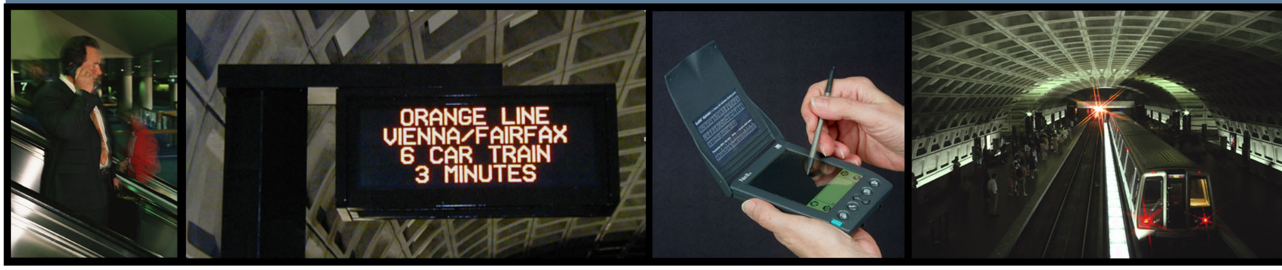
The third relevant project is TCRP Project A-20A(2), Strategies for Improved Traveler Information. The objective of this project is to identify strategies for using information technology to improve individual mobility-related decision-making with a specific focus on how public transportation providers can effectively provide transit traveler information by using new and emerging technologies to inform travelers about mobility choices. The project report includes examples of how public transportation providers can become part of regional- and community-based information dissemination systems that include, but are not limited to, hand-held (e.g., PDAs, pagers, and smart telephones), vehicle-mounted, kiosk-based, and web-based communications. The report identifies traveler information needs, assesses the state of the art in transit traveler information systems, and presents a number of case studies in the area of improved traveler information. The final report is expected to be available in Summer 2003.

RESOURCE

In addition to these three projects, results from several other federally sponsored projects provided insight into developing this Guidance document. The following projects were reviewed:

RESOURCE

- *Rural Transit ITS Best Practices*, a project conducted for the ITS Joint Program Office under the Rural ITS Program by Multisystems, with KFH Group
- *Rural ITS Non-Rider Survey*, a project conducted for the ITS Joint Program Office under the Rural ITS Program by Multisystems, with Schulman, Ronca and Bucavalas, Inc. and SAIC
- "e-Transit: Electronic Business Strategies for Public Transportation," TCRP J-09, Topic 4 – Customer Information, conducted by Multisystems with Matthew Coogan.




# Components of Successful Real-Time Traveler Information Systems

3

Based on an analysis of the information gathered from the literature review, telephone interviews, site visits, and project reviews, the primary hardware and software features of successful real-time traveler information systems in the United States were defined. The following discussion identifies these features.

Table 2-1 (shown previously) summarizes the real-time traveler information system features of the agencies that participated in this project. The descriptions of these features, provided in this section, include the hardware and software components, as well as examples of innovative approaches using these particular features.

## 3.1 Hardware Features

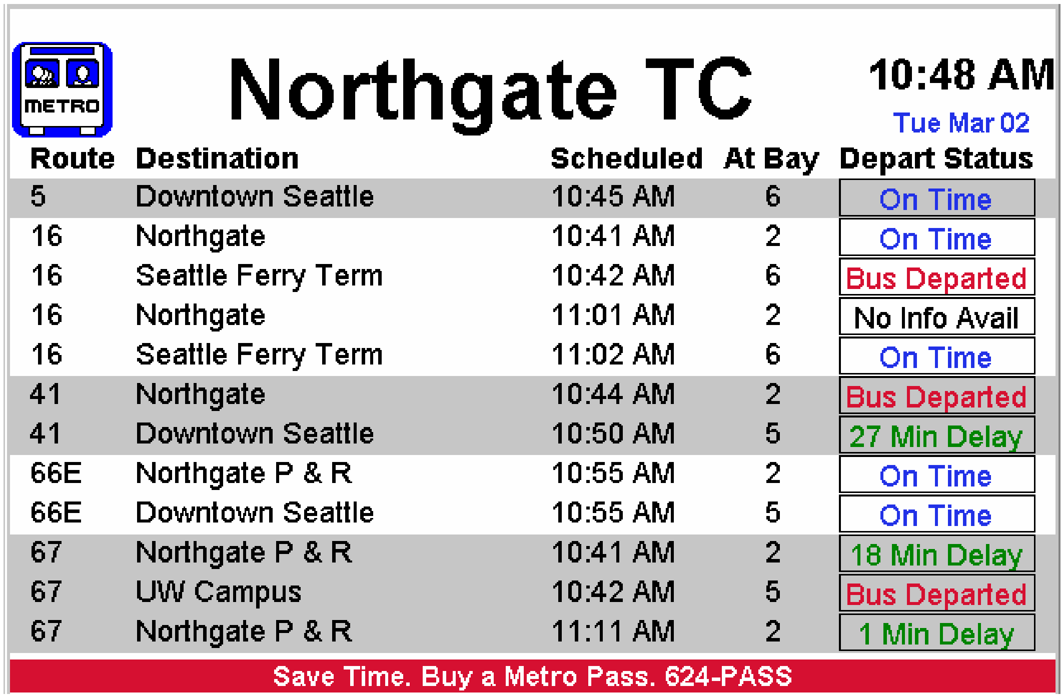
The following sections discuss key hardware features, including dynamic message signs (DMS), wireless media, automatic vehicle location (AVL), and communications.

### 3.1.1 Dynamic Message Signs

The most visible hardware feature of real-time traveler information systems is the DMS that disseminates real-time transit information at bus stops and transit stations. There are a variety of DMSs available, including light-emitting diode (LED), liquid crystal display (LCD), video monitor, and flat-panel display. The LED sign is the most prevalent, followed by the LCD. These signs come in a variety of sizes that display from one to multiple lines of text. Figures 3-1 and 3-2 show examples of LED signs used to display real-time information. Figure 3-3 shows an example of an LCD sign, and Figure 3-4 shows a video monitor.


**Figure 3-1. Portland Tri-Met Transit Tracker LED Sign**


**Figure 3-2. Washington Metropolitan Area Transit Authority LED Passenger Information Display**



Northgate TC 10:48 AM Tue Mar 02

| Route | Destination | Scheduled | At Bay | Depart Status |
|---|---|---|---|---|
| 5 | Downtown Seattle | 10:45 AM | 6 | On Time |
| 16 | Northgate | 10:41 AM | 2 | On Time |
| 16 | Seattle Ferry Term | 10:42 AM | 6 | Bus Departed |
| 16 | Northgate | 11:01 AM | 2 | No Info Avail |
| 16 | Seattle Ferry Term | 11:02 AM | 6 | On Time |
| 41 | Northgate | 10:44 AM | 2 | Bus Departed |
| 41 | Downtown Seattle | 10:50 AM | 5 | 27 Min Delay |
| 66E | Northgate P & R | 10:55 AM | 2 | On Time |
| 66E | Downtown Seattle | 10:55 AM | 5 | On Time |
| 67 | Northgate P & R | 10:41 AM | 2 | 18 Min Delay |
| 67 | UW Campus | 10:42 AM | 5 | Bus Departed |
| 67 | Northgate P & R | 11:11 AM | 2 | 1 Min Delay |

Save Time. Buy a Metro Pass. 624-PASS

**Figure 3-3. Seattle TransitWatch® Display**

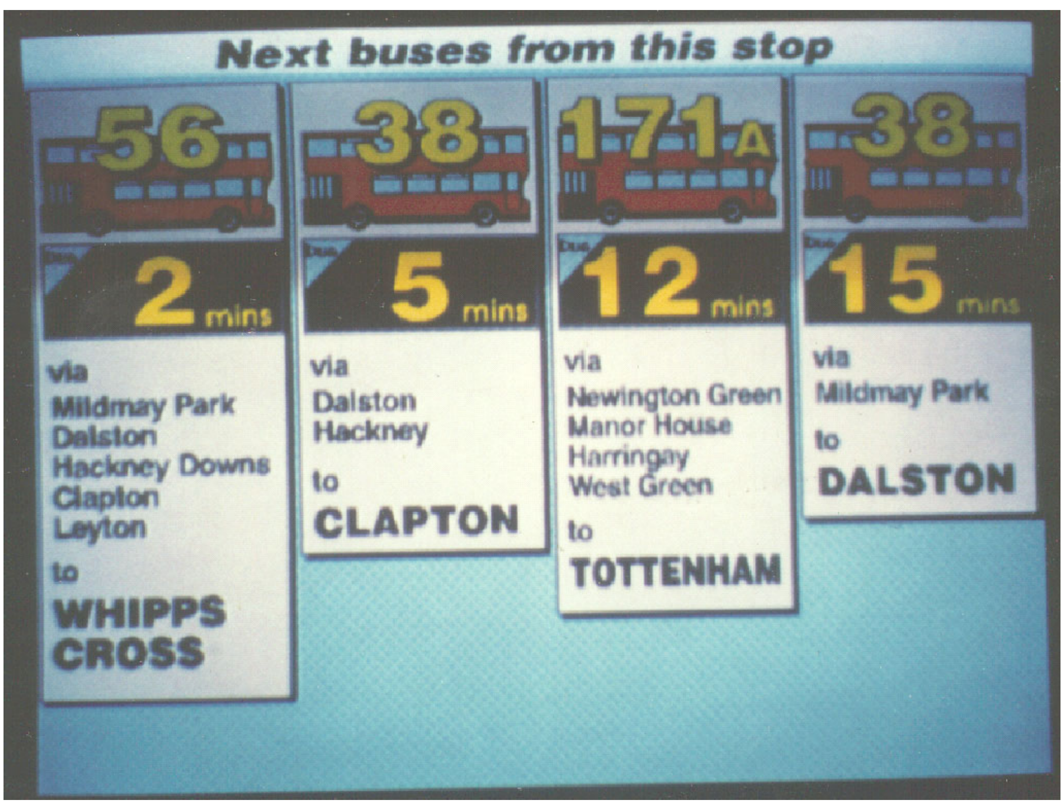



**Figure 3-4. Video Monitor Displaying Real-Time Arrival Information**

Most real-time DMSs display the same information: route number, final vehicle destination, and waiting time (presented usually in a countdown format). The most effective DMSs are capable of displaying not only the real-time arrival information, but also other messages, such as Amber Alerts, general passenger information, and items of interest, such as weather and time.

### 3.1.2 Wireless Media

Other hardware used to disseminate real-time transit information includes wireless media, such as PDAs, WAP-enabled mobile telephones, and kiosks. Wireless PDAs can have a variety of operating systems (e.g., Microsoft® Windows® CE 3.0, Palm OS®), as can WAP-enabled mobile phones. WAP is the result of continuous work to define an industry-wide standard for developing applications over wireless communication networks. Wireless Markup Language (WML), which is used in wireless devices, is a markup language based on Extensible Markup Language (XML), and is intended for use in specifying content and user interface for narrowband devices, including cellular telephones, wireless PDAs, and pagers. WML is designed with the constraints of small narrowband devices in mind, including small display and limited-user input facilities; narrowband network connection; and limited memory and computational resources. Section 3.2 describes the software associated with these devices.

Kiosks are not utilized frequently, but can be quite effective in distributing real-time information in activity centers, such as shopping malls, downtown business buildings, and hotels. Both Denver Regional Transportation District (Figure 3-5) and the Central Ohio Transit Authority (Figure 3-6) use kiosks to disseminate real-time information.


**Figure 3.5. Denver Regional Transportation District's Kiosk**

**Figure 3-6. Central Ohio Transit Authority RideFinder Kiosk**

### 3.1.3 Automatic Vehicle Location System

Perhaps the most critical hardware feature of real-time traveler information systems is the underlying AVL system hardware that provides the raw data used to calculate the estimated real-time transit information. The most prevalent AVL system for bus transit is global positioning system (GPS)-based, although several systems that provide real-time arrival/departure information are signpost-based (e.g., King County Metro in Seattle and Transport for London Buses).

**The AVL system provides the raw data used to calculate estimated real-time transit information.**

For rail systems, AVL is usually based on either signal blocks/track circuits or GPS. For example, the Virginia Railway Express Train Brain (see Figure 3-7) and Train Talk systems use GPS technology to determine the location of trains. Customer service agents use this location information to decide if the delay of a particular train should be reported to the public (e.g., if the delay is more than 10 minutes). Similarly, Tri-County Rail in Pompano Beach, Florida, equipped each train with a GPS receiver, which allows the train to determine its location continuously. The train locations are transmitted to the Customer Service Center (CSC), and, in turn, LED DMSs and the Internet display arrival times of the next train in a countdown fashion (e.g., "Train in X Minutes").

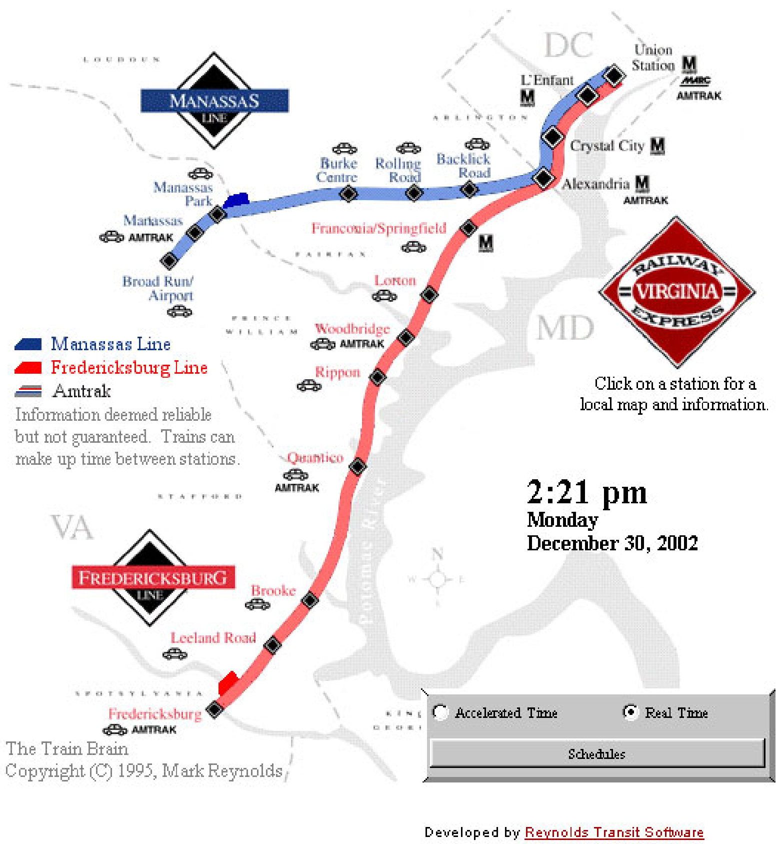



**Figure 3-7. Virginia Railway Express Train Brain**

The Jacksonville Transportation Authority Skyway system uses a Passenger Information Display System (PIDS) at each station in the system (see Figure 3-8). The real-time location is collected from the fixed blocks (cell tracks) of the automated train control system, and this location information, along with the schedule data, is processed to calculate the estimated time of arrival of the next train at each stop.

Figure 3-9 illustrates a generic AVL system for transit.


**Figure 3-8. Jacksonville Transportation Authority's PIDS**

### 3.1.4 Communication System



Another hardware feature is the communication system used to transmit the real-time transit information to DMSs. The communications technologies that are used most often to transmit information to DMSs at bus stops are cellular communications (mostly cellular digital packet data [CDPD]) and conventional telephone lines. Other technologies used less frequently include dedicated short-range communications (e.g., beacons), integrated services digital network (ISDN) lines, and T1 lines, which are dedicated telephone connections supporting data rates of 1.544Mbits per second. As mentioned during several interviews, having adequate communications coverage in the service area is critical to the success of communicating real-time information to the signs.


San Luis Obispo Transit provides an example of cost-effectively accomplishing this communication. The San Luis Obispo Transit team created two unique solutions to communications issues to keep costs at a minimum. In one solution, the system uses the standard analog voice radio system to send digital data. This approach is possible because of the unused voice radio channel capacity, where short data transmissions can fill the "gap" between voice transmissions without interfering with normal voice communication. The other innovative communication technique San Luis Obispo Transit uses is a software innovation, described later in Section 3.2.5.

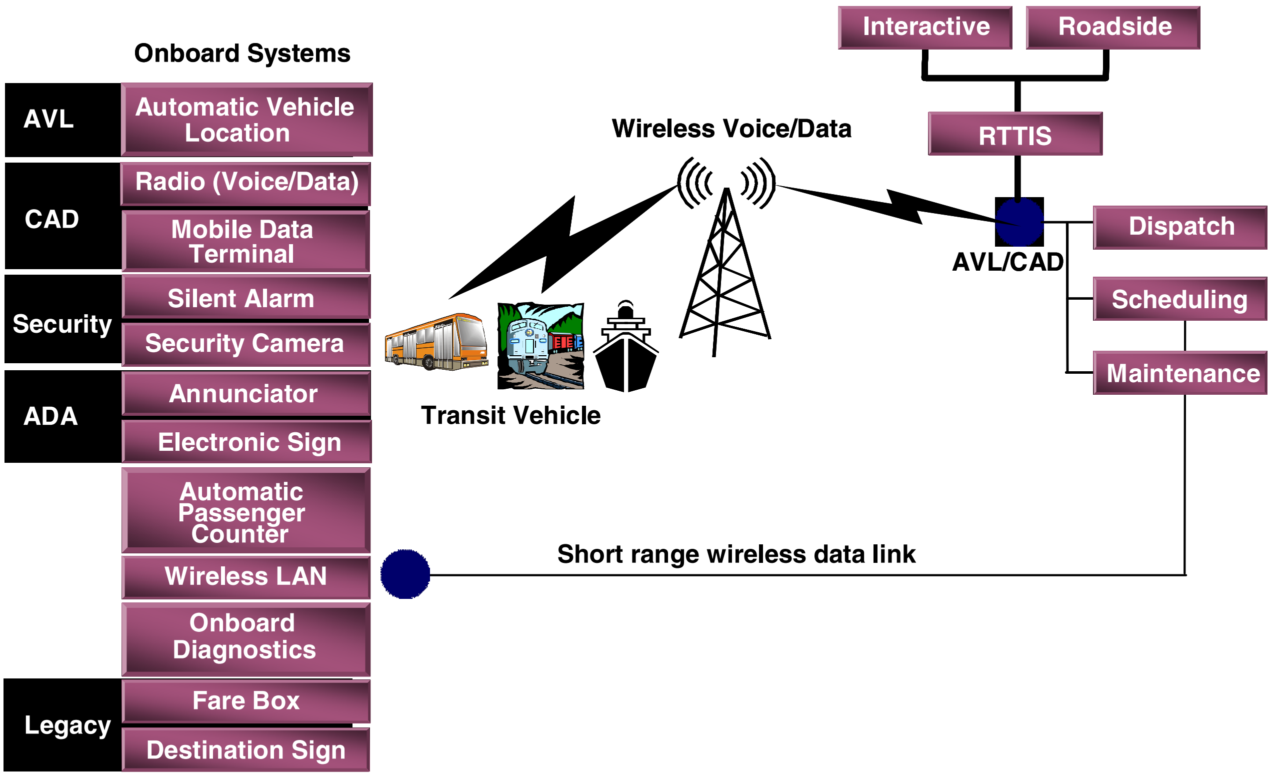



**Figure 3-9. AVL/CAD System Environment**

## 3.2 Software Features

The following discussion of software addresses prediction of real-time information, Internet and e-mail, interactive voice response, mobile real-time applications of software, and communications software.

### 3.2.1 Prediction of Real-time Information

There are a number of ways to achieve real-time prediction. The key to accurate predictions of real-time transit information is two-fold: the prediction algorithm or model, and the data that are used as input to the algorithm. In many real-time traveler information systems, including several encountered during the project, the prediction algorithms are proprietary and not disclosed by vendors who provide these types of systems. However, the interviews revealed several models that are not proprietary. Several of these prediction approaches are described below to illustrate how some of the systems actually estimate when the transit vehicles will arrive at each stop.

CHECKLIST

The Los Angeles Department of Transportation developed the Bus Arrival Information System that it uses as part of the Los Angeles Metropolitan Transportation Authority Metro Rapid bus rapid transit (BRT) system in Los Angeles. This system contains a prediction model that operates in the following manner:

- Records bus arrival time at every bus detector (an inductive loop placed in the roadway that serves as an antenna to receive the bus transponder identification code)
- Estimates bus travel time using information from last bus to traverse the same section
- Calculates arrival times for approaching buses to all bus stops.

Hu and Wong[3] describe the prediction algorithm as follows. Loop-transponders can be detected when passing through any of the 331 loop detectors throughout the two BRT corridors. Vehicle movement of every equipped bus is tracked, including the bus attributes, position, and running status. At the same time, bus scheduled arrival time points and actual arrival time points are determined. Bus travel time is a function of distance and prevailing bus speed. This system employs a technique using an innovative algorithm approach called the Time Point Propagation (TPP) method. TPP dynamically builds the schedule arrival time point table with runtime information from the prior bus arrival time for the same locations plus the active headway value of the current bus.

The actual arrival timepoint also is used for the prediction of Estimated Time of Arrival (ETA) of the next bus. ETA is calculated based on the previous bus travel time under the assumption that the current bus would experience the same or similar traffic conditions in the same segment of the corridor. The predicted bus arrival information then is transmitted through CDPD service to LED display signs at major bus stations (see Figure 3-10). According to a field survey, the accuracy of the bus arrival information is relatively high.

Dailey, Wall, Maclean and Cathey[4] created the prediction algorithm that King County Metro uses to provide real-time bus arrival information via the Internet and mobile telephone, and on LCD displays at the Northgate Transit Center. In this algorithm, "the time series, consisting of time and location pairs, is used with historical statistics in an optimal filtering framework [Kalman filter] to predict future arrivals."[5]

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3 Kang Hu and Chun K. Wong, "Deploying Real-Time Bus Arrival Information and Transit Management Systems in Los Angeles," abstract prepared for the ITS America 12th Annual Meeting, Long Beach, CA, April 29-May 2, 2002.

4 D.J. Dailey, Z.R. Wall, S.D. Maclean and F.W. Cathey, "An Algorithm and Implementation to Predict the Arrival of Transit Vehicles," available at http://www.mybus.org

5 Ibid, page 1.


**Figure 3-10. Los Angeles Department of Transportation/Los Angeles County Metropolitan Transportation Authority Metro Rapid Bus Stop Shelter Sign**

Using specific assumptions about vehicle operation and the variability of the prediction, predictions are formulated in a statistical framework and fulfill the requirements necessary to use the Kalman filter to make optimal estimates of the predicted time until arrival for individual vehicles. "The Kalman filter is a set of mathematical equations that provides an efficient computational (recursive) solution of the least-squares method. The filter is very powerful in several aspects: it supports estimations of past, present, and even future states, and it can do so even when the precise nature of the modeled system is unknown."[6]

UNIQUE APPLICATION

In Portland, Oregon, the Tri-County Metropolitan Transportation District of Oregon (Tri-Met) does not use a prediction algorithm to calculate real-time arrival information that is displayed on the LED DMSs. Information sent to bus drivers about their arrival time at the next stop is sent to the signs. Each sign has the schedule loaded in it, and the sign's processor applies the information about arrival time to the schedule to determine the offset from the schedule. This is a distributed, decentralized system, since information that will be used to determine arrival times is sent to the sign for processing. Tri-Met's Internet and wireless real-time applications determine bus arrival times centrally, using the same logic as used at each sign.

### 3.2.2 Internet/E-mail

Several agencies use the Internet to provide real-time information to their customers. In the case of Portland Tri-Met, described briefly above, the Internet application that provides real-time information requests the user's route, direction, and stop, and returns the arrival times of the next two buses at that stop based on the prediction described earlier. Denver's Regional Transportation District Internet application, called Bus Locator, works in a similar manner. The user selects a route, direction, and stop, and the Denver Regional Transportation

6 Greg Welch and Gary Bishop, "An Introduction to the Kalman filter," March 11, 2002, available on http://www.cs.unc.edu/~welch/kalman/kalman_filter/kalman.html

District provides the next two vehicle ETAs for that stop based on information from Denver's AVL system (see Figure 3-11).

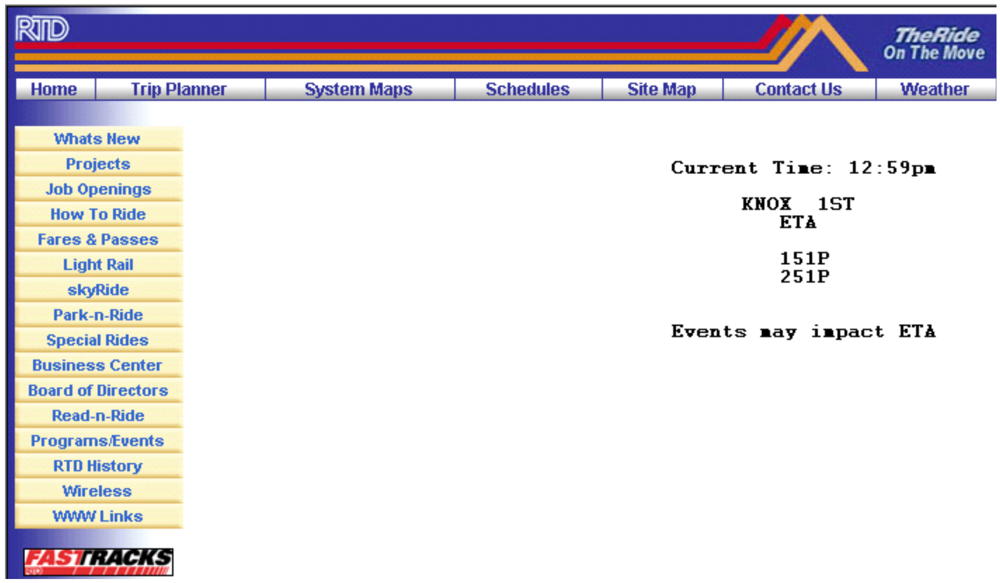


**Figure 3-11. Denver Regional Transportation District ETA Information for Next Two Buses**

For agencies such as the Fairfax City-University-Energysaver (CUE) Bus System that are using a commercially available real-time traveler information system service (see Section 5.6), real-time information can be accessed from the vendor's web site.

UNIQUE APPLICATION

Other innovative uses of the Internet include providing users with a map showing vehicles' locations and direction of travel throughout the service area. The Cape Cod Regional Transit Authority provides this service (see Figure 3-12), as well as Washington State Ferries, which provides the information through its Vessel Watch system (see Figure 3-13). Another unique application is King County Metro's BusView, in which users can set an "alarm" for notification when their bus passes a particular point along its route (see Figure 3-14). Another innovation is automatically sending an e-mail "alert" to subscribed users to notify them about changes to their regular route. King County Metro, Washington State Ferries, Virginia Railway Express, and Denver Regional Transportation District (through MyTrafficNews.com) all provide this service.

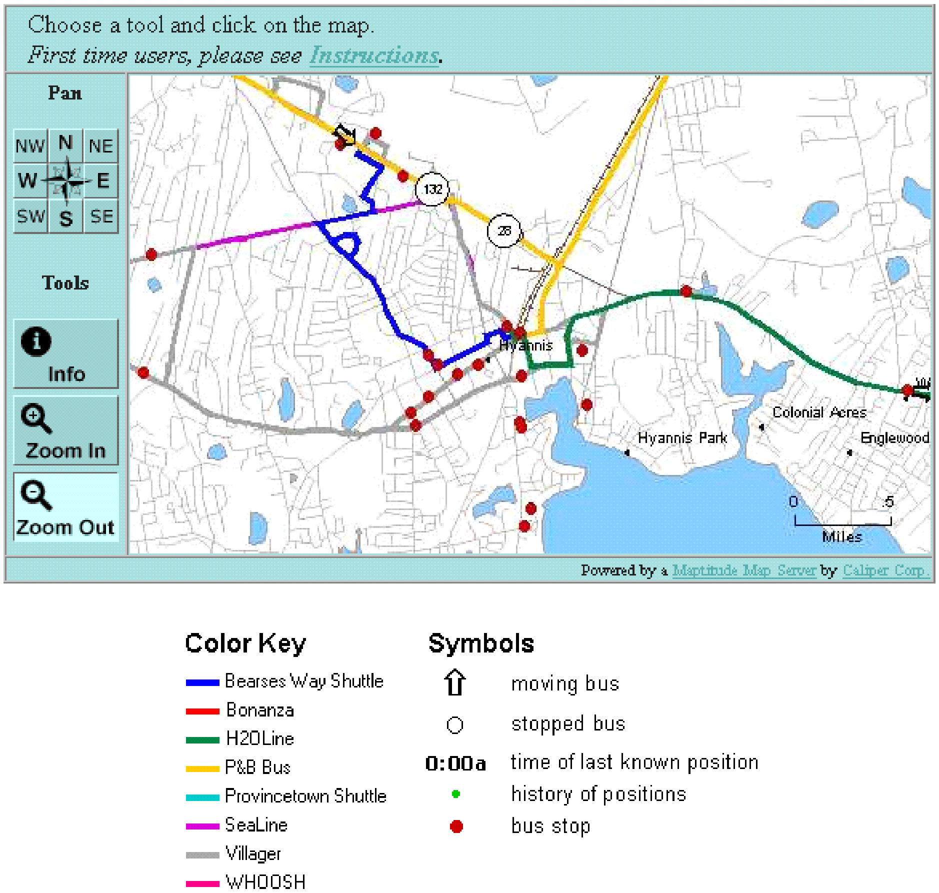


**Figure 3-12. Cape Cod Regional Transit Authority Advanced Travel Planner**

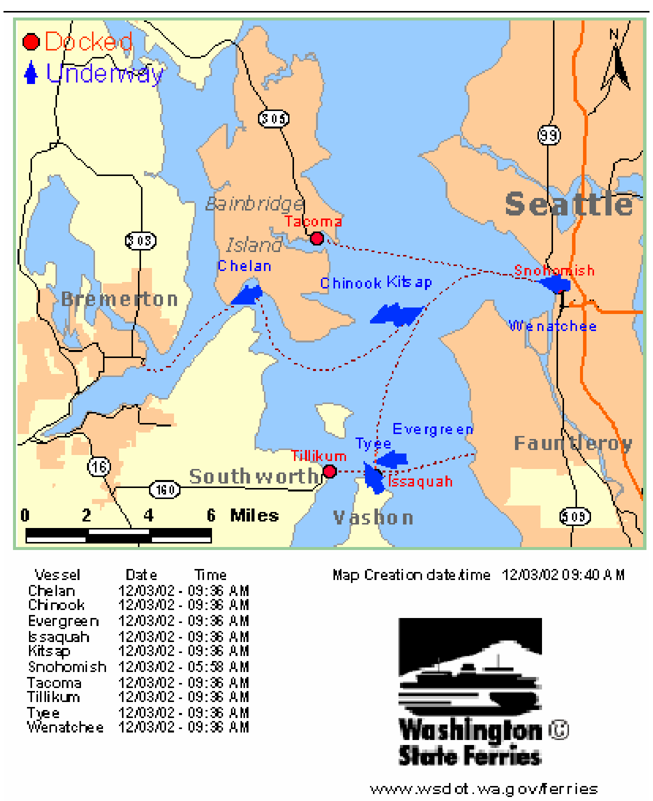


**Figure 3-13. Washington State Ferries Vessel Watch for Seattle-Bainbridge Island Route**

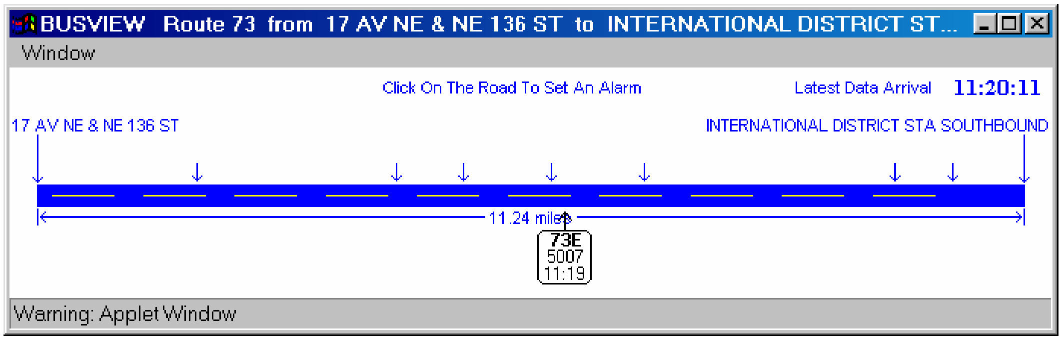


**Figure 3-14. BusView Progress Window with Alarm Setting Capability**

### 3.2.3 Interactive Voice Response

Another successful software element is that which operates interactive voice response (IVR) systems. IVR is a software application that accepts a combination of voice telephone input and touch-tone keypad selection, and provides the appropriate responses in the form of voice, fax, callback, e-mail, and perhaps other media. One successful example of an IVR system that provides real-time transit information is the Denver Regional Transportation District's Talk-n-Ride system. This system provides real-time arrival information for Denver Regional Transportation District bus and light-rail service. Implemented in December 2001, the system allows a user to call a toll-free number (1-888-RTDTRIP) and enter information on route, direction, and stop. Users then indicate if they want real-time arrival time or scheduled time. The system provides information for the next three vehicles. This system uses text-to-speech (TTS) technology, which translates schedules in XML into voice. The real-time information for this system is taken from the same server that is used to provide arrival information for the real-time Internet application, called Bus Locator.

**Denver Regional Transportation District's Talk-n-Ride system provides real-time information for the bus and light-rail service**

Virginia Railway Express's IVR system provides delay information through an 800 number. Announcements that are more detailed are voice recorded and disseminated through the IVR system. This system has a hierarchy of information. For example, if a train were late by 10 minutes or more, the telephone line would state, "there is a delay on the ___ line." To receive more information, the caller can select the line or train number and listen to the more detailed message. The IVR system also has the capability to fax the delay information to the rider upon request.

### 3.2.4 Mobile Real-Time Applications Software

As mentioned earlier, specialized software is necessary to provide real-time information through wireless devices. Mobile applications need to support multiple types of operating systems and languages. For example, Denver

Regional Transportation District also offers the Mobile-n-Ride service, which provides PDA and web-enabled mobile telephone access to real-time information, using the same customer inputs as Talk-n-Ride. The same server and software used for Talk-n-Ride and Bus Locator provides the real-time arrival information through a PDA and mobile telephone. An interpreter program determines the type of device that is requesting the information and the device's operating system. Once the system determines the device type and related operating system, the ETA prediction is calculated and provided to the requesting device in the correct code (determined by the device's operating system). For example, data are returned in WML 2.0, if the mobile telephone requesting the ETA information is running WML 2.0. The system supports 440 devices and multiple versions of XML, WML, and Hypertext Markup Language (HTML[7]).

### 3.2.5 Communications Software

Communications software is necessary for the communication hardware to function. As described earlier, several techniques can communicate the real-time transit information to stop/station signage. While the majority of the agencies interviewed use CDPD technology to communicate, several other methods have been developed to save communication costs. One example of this is the innovative communication technique being used at San Luis Obispo Transit, which has significantly lowered the operational cost of communicating with the DMS units deployed at the bus stops. Each of these units has a built-in intelligence module that allows all deployed signs to listen to a single, bundled text message sent by way of a pager. This one message contains the updated data for all signs at all stops. Each Smart Transit Sign is easily programmed to know the bus stop(s) and bus route(s) it is servicing. Once the text message is received, the "smart" sign strips out and uses only the information meant for its specific location. It then uses this information to inform the waiting passengers of the time remaining until the bus arrives at that specific bus stop. This technique allows the transit agency to limit its Smart Transit Sign communication link costs. Only one CDPD subscription is necessary for all eight Smart Transit signs, rather than one subscription per sign. This communication technique also allows expandability in the number of signs deployed.

UNIQUE APPLICATION

7 HTML is the set of markup symbols or codes inserted in a file intended for display on a World Wide Web browser page. The markup tells the Web browser how to display a Web page's words and images for the user.

# Issues and Challenges

4

Although real-time traveler information systems offer numerous benefits, as with any new technology, transit agencies often face challenges in implementing these systems. During the site visits and telephone interviews, transit agencies were asked several questions about the issues and challenges that they faced in implementing their system from start to finish. The transit agencies' staff shared lessons they have learned, barriers they have encountered, and challenges they have overcome in deploying real-time traveler information systems. Several common themes emerged while gathering information on planning, funding, required technical expertise and staff, communications, prediction algorithms, and accuracy of input and output data. The discussions that follow highlight the issues and challenges that arose during the site visits and telephone interviews.

## 4.1 Planning

As transit agencies around the country consider implementing real-time traveler information systems, it is critical that they spend an appropriate amount of time on planning such a system. The agencies participating in this project identified the following primary planning issues.

CHECKLIST

**Planning for secondary use of the data.** When the primary purpose for deploying an ITS system is related to operations, such as procuring an AVL system or monitoring vehicles for maintenance purposes, the agency may not realize the potential secondary uses of these data, such as providing real-time transit information. Because the main objective of the new system was not the dissemination of real-time transit information, the agencies often faced issues of limited functionality, future expandability, and integration with other related ITS technologies. For example, at the Washington Metropolitan Area Transit Authority (WMATA), the original purpose of the passenger information display system (PIDS) was to display information on elevator/escalator problems. Not until later in the planning process did WMATA consider displaying the information on train arrival times on the PIDS.

**Involving all affected departments.** Several agencies ran into project delays that resulted from not including all the necessary departments at the beginning of the project. Agencies ran into confusion and delays regarding the responsibilities of various departments when groups were brought into the project late in the development cycle. Other agencies ran into problems when they failed to get management support, acceptance, and buy-in early in the project. For example, Fairfax CUE experienced delays in getting power to its bus shelters during implementation of its real-time traveler information system because it did not have all the affected departments and concerned parties involved during the planning stage of the project.

## 4.2 Funding

Estimating costs and ensuring the availability of sufficient funding is a critical component of deploying any technology or system. It is critical that agencies do their research and gather accurate and realistic estimates of project costs before they begin implementation. Without proper project estimating early on, several agencies have found themselves running out of funding in the middle of a project and having to settle for less functionality than originally planned. For example, deployment of a good AVL system provides the backbone to much of an agency's real-time traveler information system. Several agencies related their experiences of beginning this two-stage implementation only to find out that their initial project estimates were inaccurate. Once their AVL system was installed and operating, they had no funds to implement the real-time traveler information portion of the project. This has resulted in agencies having to settle for diminished or reduced capabilities to provide real-time traveler information.

**Accurate and realistic estimates include funding for installation and operation, as well as funds for implementing the real-time traveler information portion of the project.**

**Reprioritizing funds.** As the nation continues to grapple with the impacts of the September 11, 2001 terrorist attacks, priorities (both funding and operational) are shifting to address potential safety and security issues. As these priorities have changed, agencies have been faced with prioritizing their budgets for more critical projects related to security and operations, even though ensuring customer satisfaction and providing their users with accurate and reliable information is beneficial to their visibility in the community.

**Selecting appropriate dissemination media.** Deploying real-time traveler information systems is dependent on the type of media used for dissemination (i.e., DMS, Internet, kiosks). For this reason, smaller agencies tend to provide real-time information through the least expensive solution, even though the selected dissemination media may not reach the majority of their customers. For example, Washington State Ferries provides real-time information on the location of its vessels through an Internet application called "Vessel Watch." The agency would like to provide this real-time information and additional information on boarding times and delays through DMSs. However, this has not been possible yet, due to the limited funds it has allocated to providing customer information and the costs associated with deploying DMSs. The Cape Cod Regional Transit Authority faced similar cost issues when deploying its real-time traveler information system through various media. Cape Cod Regional Transit Authority currently provides real-time information on the location of its buses through an Internet web page. It also would like to provide real-time information on its buses through DMSs, but, due to limited funds and the cost of deploying signs at bus shelters, this has not been possible.

## 4.3 Technical Expertise and Staff

The availability of staff and the technical expertise within the agency to deal with new technology is critical to the success of the system. Agencies often face shortages of trained and knowledgeable technical staff. Smaller agencies are typically stretched thinner and staff must "wear multiple hats," often overextending the bounds of their technical expertise.

CHECKLIST

Another key issue is data management. The underlying AVL data used for real-time traveler information systems generate a large volume of information, which, if properly managed, can be used for a variety of purposes, including creating customized reports for operations and maintenance of the system. Agencies that have spent a large amount of money procuring and operating an AVL system often have neglected to capitalize on the data generated by the system because of the lack of personnel (e.g., a data analyst) or expertise in-house to manage these data.

CAUTION

The Cape Cod Regional Transit Authority faced both of these issues. To overcome the issue of limited technical expertise, the agency used an outside consultant with experience in deploying transit ITS technology to manage the project. To overcome the issue of data management, Cape Cod Regional Transit Authority hired a data analyst to monitor the data and create reports for operations and project management.

UNIQUE APPLICATION

## 4.4 Communications

Almost all of the agencies identified the cost of communications to relay real-time transit information to DMSs as a significant issue.  Most agencies chose commercial-off-the-shelf (COTS) communication technology, such as cellular digital packet data (CDPD).  However, this type of communication can be expensive, particularly with a large number of signs.  Transit agencies across the country are looking into less expensive alternative communications solutions.

## 4.5 Proprietary Prediction Algorithms


A prediction algorithm calculates the estimated time of arrival (or departure) for a particular vehicle using location data and other information related to a vehicle's operation and is a critical component of a real-time traveler information system that provides estimated vehicle arrival time.  Existing real-time traveler information systems use either a prediction software developed by the vendor or one developed in-house.  Although on the surface predicting vehicle arrival times may not seem to be a significant technological challenge, agencies that have developed the algorithm in-house have faced significant challenges in getting the system operational and providing accurate real-time predictions.

**Existing real-time traveler information systems use either a prediction software developed by the vendor or one developed in-house.**

Agencies using a vendor's prediction algorithm have typically either provided the vendor with the agency data and allowed the vendor to develop the prediction algorithm using their own proprietary approach or they have contracted with the vendor (paying all the development costs) to develop the prediction algorithm for the agency.  Some agencies that have used a proprietary prediction algorithm have run into an issue with ownership of the data.  Although the data come from the agency's vehicles (buses and trains), some vendors have claimed ownership once these data are in their proprietary prediction algorithm.  A second issue with this approach is what the agency will do if the vendor goes out of business (or stops offering this service).  For example, San Francisco Municipal Railway faced an issue with data ownership.  It started a demonstration project in 1996 using a private service provider that had a proprietary system to provide real-time information.  The demonstration project turned into a pilot project in 1998, and was later implemented for the entire rail fleet in 1999 (see Figure 4-1).  Like other agencies that acquired a similar system, San Francisco Municipal Railway found

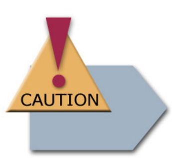



**Figure 4-1. San Francisco Municipal Railway LED Signs**

it did not own the data generated by the system; the vendor did. In 2002, when San Francisco Municipal Railway procured the same real-time traveler information system for its entire fleet, it negotiated with the vendor and succeeded in taking ownership of the data.

While paying the vendor to develop the prediction algorithm for an agency can avoid the issue of ownership of the data, it can tend to increase the overall cost to the transit agency by shifting the full cost of development and implementation to the agency instead of sharing it with the vendor. The agency also can be left open to rather significant costs associated with updates and maintenance of the system by the vendor. In order to address these issues, transit agencies are investigating ways to transition away from proprietary systems. They are assessing standard protocols that can be used to foster open-architecture-based systems. Section 5.7 provides some recommended practices on ITS architecture and standards, and how they can be applied to real-time traveler information systems.

RECOMMENDED PRACTICES

## 4.6 Accuracy of the Data

As mentioned earlier, underlying location data are one of the most important aspects of real-time traveler information systems. Agencies have faced several issues regarding the accuracy of AVL data, which in turn affects the accuracy of the predicted arrival and departure times. Often, transit agencies deploy AVL systems long before considering real-time traveler information systems. For legacy AVL systems that were implemented initially without the intention of integrating with a real-time traveler information system, agencies have found that the "accuracy" of the AVL data may not be sufficient to support the needs of the real-time information system.

Upgrades to the software or hardware components of older AVL systems may be required to address this issue to improve the accuracy of the AVL data. Experiences of agencies that have encountered this problem clearly indicate the need to have a reliable AVL system before planning real-time traveler information systems. Both King County Metro and Denver Regional Transportation District had operational AVL systems prior to the implementation of their real-time traveler information systems. King County Metro performed upgrades to its AVL system to improve the accuracy of the location data. As of December 2002, Denver Regional Transportation District is upgrading its entire AVL system with newer software and hardware features to enhance the accuracy of the location data.

Data quality directly affects everything along the information chain: "The information chain from collection of raw data through its conversion into meaningful information to its delivery to end users will usually involve a number of organizations spanning the public and private sector. A common division of responsibilities seen in partnerships is as follows. The public authority has the role of data provision and maintenance of data quality. Meanwhile the private organizations have the role of using that data to deliver (commercial) information services to the public."[8]

Thus, if the initial *data* used by a public agency to generate *information* for dissemination are not accurate, the *information* will not be accurate. This lack of accuracy of the underlying data can have significant consequences on the public's perception of the information, and, therefore, their use of the information may be reduced. Improving data quality in four key areas—level of detail, coverage, accuracy, and maintenance—in turn improves the provision of traveler information to the transit customer.

**Providing accurate traveler information for transit customers requires high-quality location data.**

The level of data detail affects transit traveler information in several ways. For example, data detail can affect routing from point A to B, depending on the customer's mode of travel. "The most suitable route for a pedestrian, for example, might not be the same as that for a cyclist both in

[8] Glenn Lyons, Reg Harman, John Austin and Alastair Duff, "Traveller Information Systems Research: A Review and Recommendations for Transport Direct," August 2001, prepared for Department for Transport, Local Government and The Regions, London, UK, page 36, http://www.dft.gov.uk/itwp/transdirect/travinf/pdf/travinf.pdf.

terms of the attractiveness of that route and its distance."[9] Further, the information generated by scheduling and itinerary planning systems that rely on bus stop inventories can be affected by the level of detail provided in the inventory. For example, if a scheduling and itinerary planning system is being used to guide a disabled person from his or her home to a bus stop or train station, it is very important to know whether the path of travel is accessible and whether the station/bus stop has services for the disabled traveler, such as escalator, elevator, or ramps. That level of detail may not be necessary for other transit traveler information applications, but it is critical in this type of application.

Data coverage can be critical, particularly when a customer is traveling within a region that has multiple modes and/or a wide geographic area. For example, if a customer is traveling from the city of San Francisco to San Rafael in Marin County, the data underlying the itinerary planning engine must contain data for transit services within the city that will take the customer to the Golden Gate Transit Larkspur ferry, but also services that connect to the ferry once at Larkspur Landing (in this case, Golden Gate Transit bus services).

Data accuracy also significantly affects the accuracy of transit traveler information. For example, if the specific geographic location of a bus stop is in error, several transit traveler information elements will be in error, including real-time arrival or departure information for that stop; on-board next-stop announcements, which could be made at the wrong time; and itineraries that involve that stop. If the location of a bus or train is not accurate, it will affect the accuracy of the prediction of when that bus or train is going to arrive at the upstream stops.

Data maintenance must be performed on a regular basis to ensure continuing data accuracy. Further, data maintenance can be optimized if an agency maintains only one database that is used for all transit traveler information applications. Often, this is a challenge because different applications need varying levels of detail and coverage. Historically, agencies have had multiple bus stop inventories, such as one to drive a scheduling system, one to drive an AVL system, and one to drive the on-board annunciation system. With just one comprehensive bus stop inventory, data maintenance is facilitated, as is building interfaces from each transit traveler information application to these data. For example, it would be ideal to have one bus stop inventory that underlies scheduling, AVL, on-board annunciation, automatic passenger counting, real-time transit information, and trip/itinerary planning.

[9] Ibid, page 9.


# Recommended Practices

# 5

Throughout the telephone interviews and site visits, agencies related practices that led to the successful deployment of real-time traveler information systems, as well as those practices that hindered deployment. In addition, research conducted as part of the TCRP Synthesis Project SA-14, Real Time Bus Arrival Information Systems, revealed even more successful and problematic practices. This section describes the practices leading to the most innovative and successful deployments, along with several examples of practices that hindered deployment.

RESOURCE

The recommended practices are presented in key stages of project development, as follows:

- Planning
- Procurement
- Implementation
- Operations and Maintenance
- Marketing.

Figure 5-1 shows where these critical processes appear in the ITS project continuum from planning through full deployment. The lighter boxes represent processes for which recommended practices are discussed in this section. Practices also are recommended for processes represented by the darker boxes, although not in as much detail. In addition, this section addresses two more areas that are essential parts of the planning process: business models, and use of the National ITS Architecture and standards. The checklist shown in Figure 5-2 highlights the key factors associated with developing and deploying real-time traveler information systems. The checklist provides a quick guide for real-time traveler information systems project discussion.

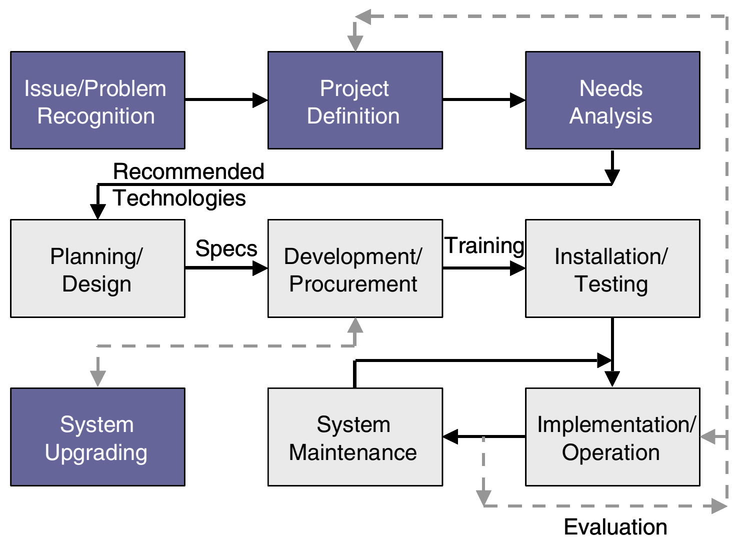


**Figure 5-1. Systems Approach to ITS Project Deployment**

## Real-Time Transit Information System

## Project Development and Deployment Checklist

### Planning

- ❑ Have all relevant departments and stakeholders been involved?
- ❑ Have project definition, goals, and objectives been established?
- ❑ Has a needs assessment been conducted to determine if a real-time transit information system is warranted?
- ❑ Have operations and maintenance costs (e.g., communication costs) been taken into account?
- ❑ Has providing power to DMSs and other wayside equipment been taken into account?
- ❑ Has eventual system expandability (in terms of number of DMSs and vehicles, and means of dissemination) been addressed?
- ❑ Is there a bus stop inventory that uniquely identifies the location of each bus stop?

### Procurement

- ❑ Has adequate internal/external technical expertise been sought and engaged?
- ❑ Have alternative procurement approaches been considered (performance-based, design-build)?
- ❑ Has integrating the real-time transit information system with other ITS systems been considered?
- ❑ Have proprietary issues (hardware, software, data) associated with the real-time transit information system been investigated?
- ❑ Has a realistic implementation schedule been established?
- ❑ Will adequate documentation (i.e. operations and maintenance manuals, system administrator manuals, and communication protocols manuals) be provided by the vendor?

### Implementation

- ❑ Have strong project management skills been sought to be engaged during the implementation of the real-time transit information system?
- ❑ Has phased implementation been considered?
- ❑ Has a formal process to track problems during implementation and operations been devised?
- ❑ Has the prediction algorithm been adequately tested under all operational conditions prior to deployment of real-time information directly to customers?
- ❑ Have appropriate internal and external departments been informed regarding the power and communications infrastructure installation schedule?
- ❑ Have clear sign-off and acceptance procedures been established?

### Operations and Maintenance

- ❑ Has proper technical support for both hardware and software been sought (either in-house, or contracting with the vendor or a third party)?
- ❑ Has adequate training been planned?
- ❑ Has the agency investigated if additional staff will be required to operate and maintain the system?

### Marketing

- ❑ Has a marketing strategy been devised to inform customers about the new real-time transit information and to promote its use?
- ❑ Have formal passenger and staff surveys been planned to fully understand the transit information impact on them?

### ITS Architecture and Standards

- ❑ Is the project part of the agency's ITS Architecture?
- ❑ Was a project-level ITS Architecture developed for the system?
- ❑ Is the project included in the regional ITS Architecture?
- ❑ Is the project consistent with FTA's Policy on ITS Architecture Consistency?

**Figure 5-2. Recommended Practices Checklist**

# 5.1 Planning

Planning an ITS project is an essential component of the process because it determines system requirements and provides details on how to meet these requirements using the least amount of resources. Planning transit ITS, when done effectively, addresses the most critical issues that will arise throughout the life of the project. Questions that must be answered in the planning stage are the *what, why, how, when,* and *how much* of the project. The answers to these questions will define the project needs, scope, and resources required for acquiring and deploying a transit ITS system, and help guide those responsible throughout the implementation process.

Appropriate planning provides control over the various phases of the project. Lack of adequate planning can lead to uncontrolled projects, resulting in the following:

- Adding system features that are not needed
- Installing equipment when not required
- Making unwarranted costly changes
- Wasting valuable limited funds.

It is no surprise, then, that one of the primary reasons for the failures of most real-time traveler information system projects is poor planning or lack of planning. Key aspects of successfully planned projects include involving relevant departments and stakeholders, and planning for communication cost and provision of power to wayside equipment.

## 5.1.1 Involving Relevant Departments and Stakeholders

The basis for sound planning for real-time traveler information systems is making sure that all relevant departments are involved in the project, especially in the initial planning and design phase. Including relevant departments such as customer service, planning, operations, maintenance, and marketing helps ensure that the project will meet each individual department's needs. Involving the stakeholders from the very beginning of the process also helps to identify the roles that each department will play throughout all project phases. Thus, involving the relevant staff will ensure more cooperation and appropriate participation throughout the project life.

**To ensure cooperation and participation throughout the project life, involve all relevant departments and stakeholders from the beginning of the process.**

Developing an overall ITS plan based on needs is an essential planning practice for real-time traveler information systems. If an agency identifies real-time traveler information systems as a need, then that agency will need to consider the real-time system along with other needs that specific transit ITS technologies/ systems can meet. The stakeholders should evaluate and agree with this carefully articulated overall ITS plan. When a department "signs off" on such a plan, that department is not only acknowledging its approval of the plan, but more importantly is showing its commitment to the project as described in the plan. In some instances, of course, the benefits of a real-time traveler information system project may not be obvious for a particular stakeholder or stakeholders. In these situations, it is important for the project initiator to explain fully the project's benefits for the specific stakeholders. Developing this argument may require the project champion to examine some published studies[10] to explain how the stakeholders can use the system to improve their service. The ITS plan should document the benefits for each stakeholder.

RECOMMENDED PRACTICES

Involving various stakeholders early on also helps in combining their resources. In turn, combining resources at the start tends to "balance the desires of those who may not fully understand all aspects of the technology. General Managers, for example, may not be aware of the technical and staffing requirements of certain technologies they support. Likewise, technical managers may not have a grasp of the legal, financial, and broader issues that must be addressed when implementing technology. Combining the resources [of the various departments] helps to ensure that the technology will be applied correctly and efficiently."[11]

The following examples highlight the importance of sound planning in developing and deploying real-time traveler information systems.

River Valley Transit is one agency that reaped the benefits of this approach. River Valley Transit is a small rural transit agency that provides fixed-route and demand-responsive services in the greater Williamsport, Pennsylvania, area and surrounding Lycoming County. The transit agency faced a problem at its downtown transit center where a number of buses would arrive at the same time and park on a "first-in, first-out" basis. This created confusion among the riders, as they did not know where their bus was parked in the transit center. As a result, River Valley Transit embarked on a technology project to eliminate this problem. Everyone to be involved in the project was included early on in the planning process, including the general manager, planner, operations manager, dispatchers, mechanics, drivers, and riders. Additionally, the agency formed an Americans with Disabilities Act (ADA) committee to address any ADA requirements associated with this project.

**River Valley Transit benefited from involving stakeholders in the process of developing their multi-function traveler information system.**

RESOURCE

[10] Documents such as "Advanced Public Transportation Systems: The State of the Art – Update 2000;" "Intelligent Transportation Systems Benefits: 2001 Update," "Benefits Assessment of Advanced Public Transportation System Technologies – Update 2000;" and the Transit ITS Impacts Matrix (available on http://www.mitretek.org/its/aptsmatrix.html)

[11] Schiavone, John, *Understanding and Applying Advanced On-Board Bus Electronics*, TCRP Report 43, Transportation Research Board, Washington, D.C. 1999, p. 87.

Initially, the primary goal set for this project was "to allow riders at the transit center to locate their respective buses in a safe, convenient manner"[12]. However, during the planning process, and due to the involvement of various stakeholders, other goals were added. The planning process identified the following additional goals:

- "Create a rider-friendly system that will allow riders to identify buses in the downtown area
- Maximize usability of the technology, with minimal requirements of drivers
- Create a data trail to monitor whether drivers are operating the equipment properly
- Create a system that is expandable as new technologies are deployed (i.e. AVL)
- Provide the ability to monitor bus movement by comparing actual arrival and departure times against the schedules."[13]

The result was a system that provides a number of functions to satisfy a number of needs. The system informs customers both visually and audibly of the bay from which each bus will arrive and depart (see Figure 5-3). The system also gives passengers a 20-second notification before buses depart the terminal. An onboard Mobile Data Terminal (MDT) (see Figure 5-4) automatically notifies the drivers if they pull into the wrong bay. The system also allows the agency to produce numerous reports that can be used for operations and planning purposes. River Valley Transit feels that by including all the stakeholders early on in the planning process it has successfully managed to meet their needs and get their cooperation during the other phases of the project.

San Luis Obispo Transit also benefited from engaging stakeholders from the inception of a project. San Luis Obispo Transit is a small bus service that operates six principal routes serving primarily a university community. San Luis Obispo Transit also connects with extensive countywide bus services at a couple of locations. To serve its riders better, San Luis Obispo Transit was interested in providing real-time arrival information at the bus stops. San Luis Obispo Transit launched a project called Efficient Development of Advanced Public Transportation Systems (EDAPTS) in 1997. California Polytechnic State University (Cal Poly) researchers and students developed and designed the EDAPTS concept and prototype equipment. Their primary goal was to design a comprehensive vehicle location and control system and real-time traveler information systems specifically for smaller transit agencies.

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[12] Multisystems, with KFH Group, *Rural Transit ITS Best Practices*, prepared for the ITS Joint Program Office, Draft Report, August 12, 2002, pp. 7-4.

[13] Ibid, pp. 7-4

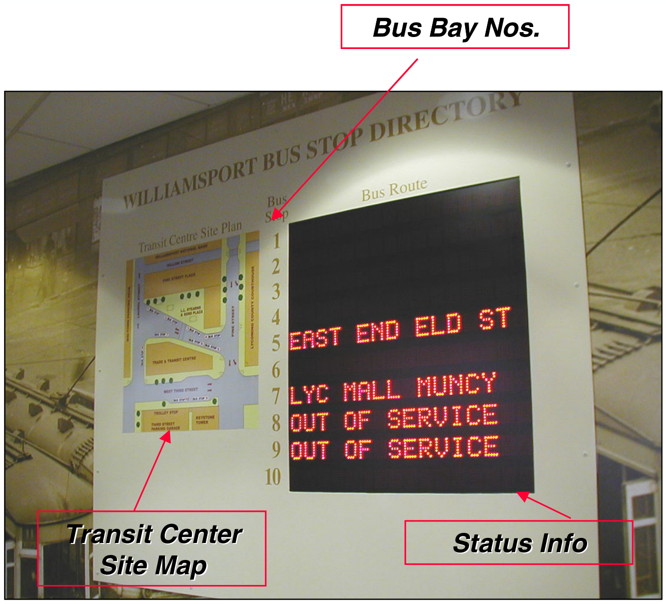



**Figure 5-3. River Valley Transit Center Sign**


**Figure 5-4. River Valley Transit MDT**

The Cal Poly team worked with the local public transit agencies to determine their basic ITS needs. They did this by performing a needs analysis while maintaining consistency with the National ITS Architecture. As a result, the process showed that the most needed ITS capabilities were the following:

- An AVL system to determine the location of all buses
- A silent alarm/emergency capability to notify dispatch about serious incidents
- DMS at selected bus stops to display arrival times of buses
- A central dispatch computer system and database
- A way to collect and store passenger data and loading statistics.

UNIQUE APPLICATION

After developing an understanding of the various needs and constraints of San Luis Obispo Transit, by involving the various stakeholders, the EDAPTS team proceeded to produce a system that provides the required functions at a low cost. Among other features of the system, the team created two unique solutions to communications issues to keep costs at a minimum. First, the EDAPTS team decided to piggyback digital data on the standard analog voice radio transmissions. Second, the team designed the DMSs with a built-in intelligence module that allows all deployed signs to listen to a single, bundled test message containing the updated data for all signs at all stops. Once the sign receives the text message, it strips out and uses only the information specific to that sign.

By engaging stakeholders and learning about their needs up front, not only did EDAPTS deliver a system that provides real-time arrival information at bus stops (see Figure 5-5) at a low cost, but also provides other features to help the transit agency and its drivers. The final product provides automatic in-vehicle audio announcements of the current and next bus stop, real-time schedule adherence information to the driver, and automatic countdown departure clock on the MDT (see Figure 5-6).


**Figure 5-5. San Luis Obispo Transit Smart Transit Sign**

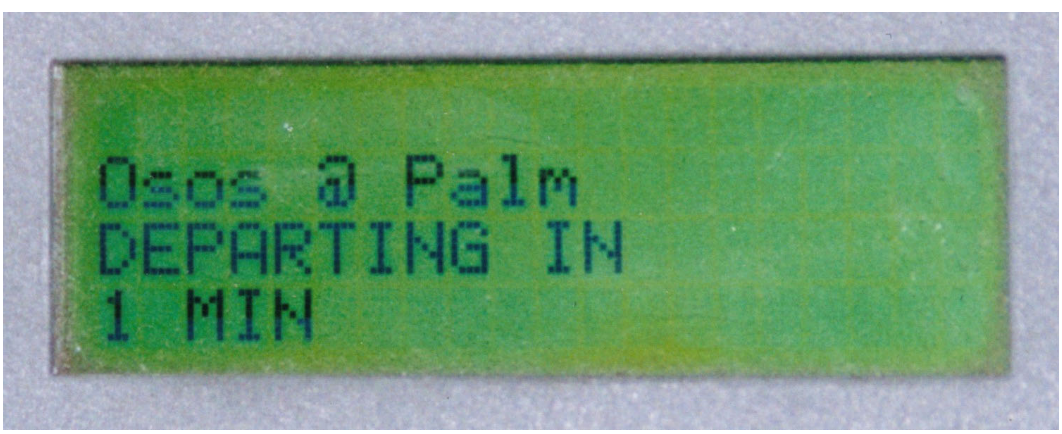
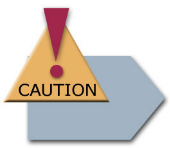



**Figure 5-6. San Luis Obispo Transit MDT Screen**

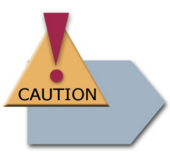
### 5.1.2 Planning for Communications Cost and Provision of Power to Wayside Equipment


Another critical area that transit agencies should consider in planning real-time traveler information systems is communications costs and the costs associated with powering wayside equipment. Most of the agencies interviewed for this project did not have any communications channel capacity issues. Available capacity was either sufficient to support the new real-time traveler information systems or was augmented in order to meet the new demand for communications. However, sound planning also should address long-term communications costs and the provision of power to stops/shelters and stations.




Investigating communication costs not only involves assessing the capital costs for acquiring the system but should include assessing the operations and maintenance costs for communication, in addition to the costs of future expansion of the system. Ongoing communication costs not properly considered in the planning stage will become a burden, especially for small-size agencies with limited financial resources. In the worst case, not planning for these ongoing costs could eventually lead to abandoning the system or to not expanding it. In either situation, the initial investment would not be well spent. The importance of considering the ongoing costs of communication is that it is much easier and cheaper to change communications requirements during the planning phase than it is after the system has been deployed.

**Proper planning for ongoing communication costs is critical to the success of real-time traveler information systems.**




Considering the feasibility of providing power to wayside equipment such as DMSs is equally as important. Agencies often overlook the availability or the ease of providing power to DMSs in the planning stages and the problem does not surface until the project is in the implementation stage. In many cases, the intended locations of DMSs, at bus stops or shelters, do not have available power. This lack of power makes running power to that location a major undertaking, and a costly one.


San Luis Obispo Transit successfully planned and conducted its real-time traveler information systems project and avoided both costly communications and expensive power supplies. Because the Cal Poly planning team did a good job in assessing the needs and financial constraints of San Luis Obispo Transit, the system they designed provided the best possible situation for San Luis Obispo Transit: a system tailored for San Luis Obispo Transit's available resources. To avoid the costly and lengthy process of running power to proposed DMS locations, the team chose to install solar-powered signs (see Figure 5-7), which eliminated the need to dig up sidewalks to run power cables and make costly electrical connections. San Luis Obispo Transit installed eight solar-powered signs in San Luis Obispo and on the Cal Poly campus. The signs are capable of operating for up to 20 days of inclement weather, which makes them very reliable.

Moreover, having realized the limited financial resources of San Luis Obispo Transit, the Cal Poly team set out to devise a low-cost solution for communicating with the signs. Instead of having a separate CDPD subscription for each of the DMSs, the Cal Poly team incorporated a built-in intelligence module in the signs that allows them to strip specific data elements from a single bundled text message that is broadcast to all signs. This approach allows all eight signs to use only one CDPD subscription rather than one subscription per sign. Therefore, the total CDPD charge for all eight signs is $35 per month. This solution was immediately affordable and will be flexible when San Luis Obispo Transit installs more signs.


**Figure 5-7. Solar Panel Mounted on San Luis Obispo Transit Smart Transit Sign**

UNIQUE APPLICATION

The Central Ohio Transit Authority (COTA) offers another example of the benefits of effective planning. When the agency initiated its real-time bus arrival information system (called RideFinder), one of the issues considered early on in the planning was power supplies. The agency was interested in placing kiosks at a number of major hotels in downtown Columbus and at the convention center and airport. Because RideFinder had a very limited budget, the agency placed the kiosks in hotels that would provide power and telephone connections to the kiosks at no cost to the agency. COTA approached the city's convention center and airport with similar requests. Recognizing the benefits to their customers, all the establishments happily provided the required communications and power. By addressing the issue of the cost of providing communications and power to kiosks early on in the planning process, COTA was able to establish a public-private agreement that saved the agency valuable financial resources.

The examples of San Luis Obispo Transit and Central Ohio Transit Authority are cited to demonstrate that there are innovative ways to handle often-overlooked issues such as communications and power. The above examples highlight the importance of understanding the agency's needs and constraints when considering and deploying real-time traveler information systems. Once the agency understands the needs and constraints, it can design a system that considers these factors, enabling the agency more effective system implementation and potential expansion that will not unnecessarily strain often-limited resources.

## 5.2 Procurement

Procurement is another critical aspect of the process of deploying real-time traveler information systems. Sound procurement procedures and policies reduce complications and problems, and ensure that the planned system meets the requirements that were set forth in the planning stage. In some instances, failure to ensure sound procurement procedures has resulted in canceling a whole project because of major problems and cost overruns encountered during the implementation phase. When this happens, the agency not only loses the chance to reap the benefits of the planned system, but also loses a sizable financial investment. In other instances, procurement issues did not surface during implementation, thus providing a false sense of "security" during that phase. In many cases, agencies have discovered that the system they have deployed and accepted, and are operating, does not provide the functionality that they expected. The system may not allow access to the data or it may not be easily expandable. Using established procurement procedures and processes supports the careful planning and deployment of the system. Understanding the technology, procurement approaches, and proprietary issues will enable an agency to achieve its goals more rapidly.

**The success of the project ties directly to the procurement process.**

### 5.2.1 Engaging In the Technology Talk

Historically, transit operations or information technology departments have initiated and implemented transit ITS projects. Although the transit personnel may have a good understanding of their agency's needs, they may not have the understanding of ITS requirements needed to plan and implement real-time traveler information systems.

ITS presents a challenge to transit agencies unlike any other technology implementations (e.g., a radio system for a specific use by a specific department). Intelligent transportation systems usually affect numerous transit agency departments, providing data and requiring support. An ITS application can influence an agency's operations, ridership, revenues, and image. Successful transit ITS requires knowledge of transit operations, planning, scheduling, communications, and Federal requirements. Having ITS expertise within the agency will greatly facilitate the procurement of real-time traveler information systems. Several of the agencies interviewed during the development of this document stated that they wished they had the internal expertise on ITS systems to guide them through the procurement process. Some agencies that realized their lack of expertise obtained the assistance of consultants. Retaining outside assistance can be helpful, in some cases essential, and the agency should consider obtaining this assistance throughout the life of the project.

Portland's Tri-Met is one agency that has built a solid internal ITS knowledge base. Several Tri-Met staff have expertise in the area of transit ITS technologies and needs, and have been involved in a number of deployment projects. Tri-Met greatly benefited from using its internal ITS expertise during the procurement phase of its real-time traveler information system, called Transit Tracker. The Transit Tracker system, which is being implemented (as of December 2002), will provide real-time arrival information at selected bus stops and light rail stations. Tri-Met has installed 21 LED DMSs, as of summer 2002. Tri-Met is planning to install 50 more signs by the end of 2002, with a total number of 250 signs installed by 2004.

At the time Tri-Met was interested in procuring real-time traveler information systems, its AVL vendor did not have a fully developed real-time information system that they could sell to Tri-Met. Another vendor specializing in real-time traveler information systems had a proven functional system that numerous sites around the country were using. Tri-Met thought this system offered a viable option. However, after examining the system further, Tri-Met recognized the drawback of obtaining such a system. Tri-Met realized that if it procured this system it would be acquiring *a service* rather than *a system* that it would own and operate. The staff was also not comfortable with the vendor's business model. Based on this evaluation by its staff, Tri-Met elected to postpone its procurement until the AVL vendor had developed a real-time system rather than acquire a system that the agency would not control.

### 5.2.2 Determining Procurement Approaches

As stated earlier, the success of the project ties directly to the procurement process. Procurement processes also set the tone for the project's timetable, as well as the change management process. Another aspect of the procurement process that agencies ignore is the potential conflict among vendors and contractors that can arise during the implementation phase. Thus, it is crucial that the procurement approaches ensure that the project meets its planned objectives. Moreover, employing the appropriate procurement approach will help in making the implementation process go smoothly.

One way for agencies to avoid problems in deploying the real-time traveler information systems is to employ a performance-based contract with the vendors. In a performance-based contract, the agency establishes a specific set of milestones and ties them to a payment schedule. The agency pays the vendors only upon the successful completion of each milestone. The benefit of this approach is that it establishes an incentive for the vendors to deliver an operational system according to the established project schedule, and it helps the agency to maintain more control during the implementation period.

RECOMMENDED PRACTICES

Design-build offers another approach to the procurement process. Historically, transit agencies have used low-bid processes for construction-related projects. However, for some projects, such as ITS, low-bid procurement processes have not resulted in successful projects. Agencies should not use this traditional procurement method to acquire software, particularly if the vendor will need to customize the software to meet specific agency needs. Intelligent systems and software are not all the same, and they cannot be compared on equalized or leveling terms. Systems from different vendors can have different functions and components, and vendors may follow different approaches in implementation and integration. This makes comparisons that are necessary when using a low-bid process more difficult.

To deal with these concerns and make it easier to compare “apples to apples,” transit agencies may request unit pricing and start-up costs. This has an added advantage, as it allows reasonable estimation of downsizing or expanding the project scope. Agencies also may consider using a competitive, negotiated contractor-selection process. Competitive negotiation will permit bid revision; avoid the low-bid requirement; allow re-scoping or re-sizing to fit the budget; and allow adjustment of specification to gain greater functionality and/or lower cost.[14] Other benefits of the design-build approach include shifting the risk/liability to the contractor, lessening administrative burden, encouraging innovative solutions, and shortening procurement and implementation phases.[15]

UNIQUE APPLICATION

River Valley Transit employed the design-build approach in the procurement of its transit information system (TIS) in 1998. Although the agency had some preliminary functional design work for the system, the contractor was responsible for all aspects of the system. The agency did not give narrowly defined system specifications in the request for proposals (RFP), which encouraged the vendor to be creative in designing a solution. The River Valley Transit staff was able to engage in a creative design session with the vendor that resulted in an appropriate solution. River Valley Transit received a system that met its requirements and expectations.

San Luis Obispo Transit also pursued a design-build approach. Cal Poly researchers and engineering students developed, designed, and built San Luis Obispo Transit’s real-time traveler information system. The design-build approach employed by San Luis Obispo Transit allowed the Cal Poly team to be creative in designing a system completely around San Luis Obispo Transit’s

[14] Okunieff, Paula, *AVL Systems for Bus Transit*, TCRP Synthesis of Transit Practice 24, TRB, Washington, D.C., 1997, p. 29.

[15] Ibid

requirements and budget constraints: a system that kept communication costs to a minimum. In addition, San Luis Obispo Transit dealt with a single vendor throughout the life of the project, minimizing the use of San Luis Obispo Transit's staff time and resources.

The experience of the City of Helsinki, Finland, provides a less-than-positive example of contracting with multiple vendors. By contracting with more than one contractor, Helsinki encountered a liability problem during the deployment of its real-time traveler information system. The system, deployed in the mid 1990s, provides real-time bus arrival information in a countdown manner. DMSs display the information at various bus stops. The City had separate contracts with the two vendors: one for the management system and one for the DMSs at bus stops. When the agency encountered technical problems involving the establishment of reliable communication between the central management system and the information displays at the bus stops, disagreements about the vendors' liability and responsibility regarding the communication compounded the issue. Each vendor was claiming that the communication problems were the fault and, hence, the responsibility of the other.

### 5.2.3 Using Proprietary Systems

One of the problems that some agencies face when acquiring a new system is the use of proprietary systems. A proprietary system may not be an issue for some applications or agencies, but in the case of transit ITS, it can have adverse results, as it may inhibit expandability, integration, and ownership of data.

Some of the agencies interviewed for the project that had acquired proprietary real-time traveler information systems indicated that choosing a proprietary system might have not been the best decision. One agency in particular was displeased because it now has a problem with expandability of the system. It is a common practice (and in fact a recommendation) among transit agencies deploying real-time traveler information systems to start out with a limited deployment, installing DMSs, for example, at a small number of stops and/or stations. With time, and as more funding becomes available, these agencies tend to expand their systems to equip more stops/stations with signs. Hence, a proprietary system may be a major factor in terms of whether the agency will be able to expand its system.

Using proprietary systems also complicates integration of various systems. By developing a regional ITS architecture and following a systems engineering approach, agencies can define requirements and functions for the real-time traveler information system that a vendor can trace between its system and that of the local architecture. With this and the use of ITS standards, it will be easier for agencies in the future to integrate multiple systems and expand existing systems, without necessarily relying on the initial system vendor. Being able to integrate systems can result in cost savings in the procurement, operations, and maintenance phases. For example, when several on-board systems share a single GPS receiver, the agency should acquire, operate, and maintain only one GPS receiver.

A new issue with proprietary systems that has surfaced recently is the ownership of data generated by ITS systems. Some agencies that have acquired real-time traveler information systems from a vendor found out later that they did not own the vehicle location and other system-generated data. Data are a valuable commodity to any transit agency, as the agency can sell it, in addition to using the data for planning, scheduling, maintenance, operations, marketing, and legal purposes.

Just because a proprietary system is the only system available at the time of procurement, it does not mean that an agency has to settle for such a system. Tri-Met provides an excellent example. Although the only available option was a proprietary system at the time they were considering deployment of a real-time traveler information system, Tri-Met preferred to postpone the procurement and wait for its AVL vendor to create the system. This allowed Tri-Met to get a *system* that it owned and operated, rather than procure a real-time information *service*.

**Agencies should not feel restricted to using a proprietary system.**

San Francisco Municipal Railway also faced an issue with data ownership. In 1996, San Francisco Municipal Railway started a demonstration project to provide real-time next train arrival information. The agency used a private service provider that had a proprietary system. The demonstration project turned into a pilot in 1998, and later was implemented for the entire rail fleet in 1999. The system provides arrival times at rail stations via LED signs. Like other agencies that acquired a similar system, San Francisco Municipal Railway did not own the data generated by the system. In 2002, when the agency procured the same real-time traveler information system for its entire fleet, it faced a dilemma. On one hand, it was satisfied with the quality of the deployed system and the vendor's service. However, on the other hand, San Francisco Municipal Railway was not satisfied that it did not own the data. Therefore, when it negotiated the final contract, it requested ownership of the data and the vendor consented to the request.

King County Metro experienced the problem of proprietary systems during the deployment of the BusView and MyBus systems. The University of Washington developed the applications under the Smart Trek Metropolitan Model Deployment Initiative (MMDI). BusView is an Internet application that displays the current location of buses on a map. Users also can add an alarm clock along a particular route on the map that will notify the user, audibly and visually, when the next bus arrives at that particular point. MyBus is another application that provides actual arrival time of buses for any route. Both of these applications require location data in order to display location of buses on the map and to perform arrival prediction. Metro's existing AVL system could have provided the location data, had it not been a proprietary system. Getting the required data from the AVL system, therefore, became more complicated. The solution to this proprietary issue was designing the real-time traveler information systems to "listen in" on the proprietary system to obtain the vehicle location data.

Notwithstanding the above discussion of proprietary systems, a proprietary system may be suitable for certain agencies. A proprietary system may be a viable solution for an agency that is not planning to implement an AVL system, or is not planning to deploy a broader ATIS in the long term. However, it is important that whichever system an agency selects, that system should be capable of integrating with other related transit ITS systems in the agency and the region.

CHECKLIST

## 5.3 Implementation

Unlike many transit procurements, ITS procurements in general, and real-time traveler information systems in particular, do not merely involve installing equipment on-board vehicles, at stops and stations, or at agency facilities. Real-time traveler information systems also involve modifying a communication system, installing software, and integrating with other agency or regional systems. This highlights the importance of adhering to comprehensive implementation procedures and processes to ensure a successful deployment. Following such procedures will contribute greatly to adhering to the project schedule, budget, and system requirements. Planning and procurement are critical to the success of the project; however, during the implementation phase, the agency will execute the specific requirements set forth in these previous phases as defined in the contract.

**Successful deployment of a real-time traveler information system requires clearly defined implementation procedures and processes.**

One of the essential ingredients for successful deployment is for agencies to allow adequate time for implementation. While the implementation schedule may be politically driven, trying to install and implement a new system and technology too quickly can create problems that will be difficult to correct in the future. An incremental approach to system start-up often enables an agency to avoid these pitfalls. "Additionally, if implementation is too rushed, staff may not have time to become accustomed to the technology and, therefore, may not fully realize its potential benefits."[16]

RECOMMENDED PRACTICES

Avoiding change orders whenever possible is critical. In every deployment of an ITS system, including real-time traveler information systems, agencies will discover, in the implementation phase, new system features or "bells and whistles" that they could acquire to enhance the procured system. Known as "feature creep," this continual attempt to add to the system can cause the re-design of

CAUTION

[16] Multisystems, with KFH Group, *Rural Transit ITS Best Practices,* prepared for the ITS Joint Program Office, Draft Report, August 12, 2002, p. 8.

major components of the procured system. At best, it could be a source of cost over-runs. One agency interviewed had its project cost increase from $5 million to $12 million due to numerous change orders (such as increasing the number of DMSs, changing material specifications of the sign enclosures, and changing the specification of the sign pedestals). Therefore, agencies should remain focused on implementing what was set forth in the system requirements and specifications, and articulated in the contract. Agencies will have more success if they postpone modifications and changes until after the project is complete.

RECOMMENDED PRACTICES

Patience is also essential for a successful implementation: delays are inevitable. Agencies need to be patient and flexible during the implementation process, particularly when problems arise, as it is very rare that everything will go exactly as planned. Maintaining a good working environment with the vendor and contractors facilitates resolving issues and minimizing delays. In addition to understanding that delays will occur, agencies need to accept that the delays will likely incur additional costs and staff time. Including contingency funding in the project budget will help reduce the anxiety that can accompany implementation delays.

### 5.3.1 Conducting Phased Implementation

RECOMMENDED PRACTICES

Agencies with successful real-time traveler information systems also recommend using a phased implementation approach. Phased implementation can take the form of first piloting the implementation on a small portion of the fleet. Following an incremental implementation approach allows the agency to work out problems before full-scale deployment. Detecting and analyzing problems is easier and faster during this phase when only a limited amount of hardware and software is involved. Furthermore, it is faster, and hence cheaper, to replace or fix a limited number of units, after correcting a problem than having to replace all the units once full installation has taken place. Moreover, applying technology to a limited number of buses gives operations and maintenance personnel time to become familiar with new technology. Limited applications also can be helpful in evaluating the effectiveness of certain technologies without making large investments and can be useful in ensuring equipment functionality.[17]

**The phased implementation approach makes detecting, analyzing, and fixing problems easier, faster, and cheaper.**

River Valley Transit provides an example of an agency that followed this approach. In the course of implementing River Valley's real-time traveler information system, the vendor installed the equipment on one vehicle only. River Valley put the vehicle back into service and tested it, which allowed the agency and the vendor to work out bugs and to complete the vehicle-acceptance

[17] Schiavone, John, *Understanding and Applying Advanced On-Board Bus Electronics*, TCRP Report 43, Transportation Research Board, 1999, p. 93.

test successfully. Installation on the entire fleet followed, which went smoothly since the agency and the vendor had worked out most of the problems already.

Washington Metropolitan Area Transit Authority also followed a similar approach. Before fully deploying all of its 450 PIDs, it installed eight signs and tested the system. Once the bugs were resolved, the agency installed the rest of the signs. However, upon completing the deployment of all signs, a software problem emerged. A particular piece of software was not designed to handle the number of signs being deployed. Consequently, the software was causing a long latency in delivering the data (up to two minutes), making the system "hardly" real time. The software was eventually modified and the problem was rectified. This example also points out that *no approach is foolproof*: even though the agency followed the proven approach, and resolved the known problems, other unexpected problems may arise.

### 5.3.2 Using Prediction Algorithms

Real-time traveler information systems provide arrival-time predictions by using a prediction model or algorithm. The accuracy of the predicted arrival time is contingent on the accuracy of the model/algorithm and the data the system uses. However, measuring the accuracy of the predictions cannot occur fully until specific portions of the real-time traveler information system are functional (i.e., pilot fleet), at which point the agency can compare predictions to actual arrival times. Each agency has unique factors that will affect the computation of predictions. These factors may include the loss of GPS or signpost signals in certain areas, operational issues such as interlining or leap-frogging, or simply programming errors. Therefore, agencies procuring real-time traveler information systems should expect prediction errors during the implementation phase. Close cooperation with the prediction model developer will help the developer understand specific operational procedures and activities that could be the source of prediction errors. This knowledge will assist the developer in improving the model results more quickly.

CAUTION

While implementing its real-time bus arrival information system, Los Angeles Department of Transportation encountered some problems with the prediction model it was using for the Los Angeles Metropolitan Transportation Authority Metro Rapid service. One of the more serious problems encountered in the prediction software was the issue of leap-frogging, which is when a bus goes ahead of another bus running on the same route. The prediction algorithm could not handle leap-frogging, which was disrupting the prediction time. Once the agency discovered the cause of the problem, the algorithm was modified to handle that phenomenon. LADOT mentioned that information regarding how to improve arrival prediction time would have been helpful as it was developing the prediction software.

**Testing and evaluating the prediction algorithm is critical to ensuring accuracy of traveler information.**

King County Metro's system, developed by the University of Washington, also experienced prediction errors initially. The prediction algorithm was not reflecting the actual conditions on the street (i.e., traffic conditions). Models that are constantly updating parameters used in the prediction equations (i.e., average speed by time and day) on a daily or semi-daily basis tend to produce far more accurate arrival times. Therefore, it is important to understand the variables and data used in the prediction algorithm to ensure reliable and accurate output.

Given the issues with prediction models, it is always a good practice to test and validate the accuracy of the model. "Some agencies monitor both the AVL and real-time arrival information systems directly (usually from a central location) to determine the accuracy of the predictions. Either this monitoring can take place in real time or historically, using data logs from the signs and/or central system. Others conduct field visits to compare actual bus arrival times to the time depicted on the dissemination media. Several agencies do not monitor prediction accuracy at all. One agency reported that it measures the variation in predicted arrival time for ten, five and two-minute predictions, and checked the number of accurate predictions within plus or minus 25%."[18]

### 5.3.3 Defining Infrastructure Requirements

Appropriate technology infrastructure is vital to providing reliable real-time information efficiently. Infrastructure elements—whether communications or power—are susceptible to frequent breakdowns and will deteriorate the reliability of the real-time traveler information system and the information provided. Frequent breakdowns eventually will lead to eroding customers' trust in the system and, in turn, the agency. Therefore, when implementing a real-time traveler information system, an agency should consider carefully how and where it installs communication equipment, how the system integrates its components, and which communication services and Internet service provider it selects. In addition, the agency should coordinate closely with local agencies early in the implementation process to facilitate providing power to DMSs that it intends to install at public rights of way.

**Avoid downtime and possible loss of customers' trust with careful consideration of location, installation, and integration of communication equipment and components.**

Providing power to DMS installation locations challenged some of the agencies. Two agencies in particular experienced this situation. Running power to a bus stop usually involves more than one city department, including departments of public works and traffic and signals. Adding the transit agencies' involvement and their contractors to the mix can make the task of coordinating the effort of providing power complicated and lengthy. City departments are usually very busy with critical projects of their own and, thus, may give a real-time traveler

[18] Schweiger, Carol, *Real Time Bus Arrival Information Systems*, TCRP Project J-7, Synthesis SA-14, Draft Report, October 2002.

information system request lower priority. In order to avoid these situations, transit agencies should include these players in their planning efforts and maintain close coordination with them throughout their implementation phase. After all, not being able to provide necessary power to the wayside equipment will result in not having a working system if the system requires wayside DMSs and related equipment. At best, delays in getting power to these sites will mean schedule delays and potential cost overruns.

Many of the currently deployed real-time traveler information systems can provide information to their customers through a variety of media. Often, users can access information via the Internet, e-mails, pagers, PDAs, cell and landline telephones, DMSs, and kiosks. Each of these media requires its own type of communications infrastructure, including Internet connections, wireless services, T1 lines, landline telephones, and cable services. Transit agencies should familiarize themselves with the current communication technologies in terms of what they have to offer, their cost, and what support they will require from the transit agencies.

As previously stated, some agencies that use CDPD communication for their DMSs discovered later that the ongoing communication costs are significant. The slow-speed connection between the main computer and the DMSs at their train stations had an impact on another agency's real-time traveler information system. Therefore, agencies should evaluate their selection of the appropriate communication system as faster, cheaper, and more reliable communications options become available. There is no right or wrong communications technology or service for a particular information dissemination media. The agency should look at the optimum solution that meets *its* real-time traveler information system needs as well as its operations and maintenance budget. Agencies should use internal and external expertise on this issue whenever possible.

CAUTION

## 5.4 Operations and Maintenance

When the system passes all acceptance tests, it enters the stage where it ceases to be a "project" and becomes an operational system. It is also at this stage, commonly referred to as operations and maintenance (O&M), that unexpected problems and issues can arise. Sometimes it is only after implementation that communications are tested under actual operational conditions; staff knowledge of operations and maintenance is tested; reliability and performance of the hardware and software are monitored; and other aspects of the system are tested. The first part of the O&M phase represents a steep learning curve for most agencies, no matter how well the agency has trained. However, with the appropriate amount of preparation and planning, agencies can avoid many of the common O&M problems.

CHECKLIST

RECOMMENDED PRACTICES

Although the O&M stage is only one of usually five or six phases during the life of a project, it is the longest period. It may take anywhere from one year to three or four years from the time an agency plans a system to when it is completed and fully implemented. Operations and maintenance, on the other hand, lasts for anywhere from four or five to as many as 10 to 12 years. Therefore, agencies implementing real-time traveler information systems should address the system's ongoing O&M needs, such as providing training, maintaining the system, ensuring adequate staff and other resource needs, monitoring the system and the data, and updating inputs (i.e., schedules and stop locations).

### 5.4.1 Choosing Operations Alternatives

Not all real-time traveler information systems are designed, built, or operated the same. Just as the components and functions of a system differ from one vendor's product to another, the way agencies operate and administer real-time traveler information systems also differs. The operations of a real-time system can range from requiring constant manual input to almost no involvement on the part of the transit agency.

**Transit agencies are using a range of operational alternatives, from fully automated information services to systems requiring significant manual input.**

One system that requires constant manual input is Virginia Railway Express's (VRE's) system. VRE offers two real-time transit information innovations, Train Brain and Train Talk, unrelated projects that convey information about current train delays to the riders over the Internet: Train Brain through a web site and Train Talk via e-mail. Train Brain is a schedule-based java applet program that displays the location of VRE trains on a map on the VRE web site. The system is not fully automated, as it requires staff to decide on reporting delays. Location data from each train are sent to the main computer where they await staff action. Customer service agents must then verify the delay before a delay message is prepared. Similarly, Train Talk, which is an e-mail service about service delays and disruptions, is not a fully automated system. Customer service agents must initiate sending the e-mail alerts. Usually, only major delays and service disruptions are sent through e-mail.

At the other end of the spectrum are systems that provide an automated real-time information service, such as that provided by a well-known vendor. The company's service provides arrival information at bus stops and train stations and on the Internet. A GPS receiver on-board the transit vehicle is used in the vendor's system to obtain vehicle location data. The data are then transmitted through CDPD to the vendor's main computer, with all data processing taking place at the vendor's headquarters. Once arrival time is computed, the information is then posted on the Internet and transmitted to the appropriate DMS at the bus stop or train station. Because all data processing and system administration take place at the vendor's operational center, there is a minimal operational effort on the part of agencies that have acquired this service.

Between the two ends of the spectrum are systems such as those acquired by the Washington Metropolitan Area Transit Authority, Cape Cod Regional Transit Authority, Jacksonville Transportation Authority, and a host of other agencies that require continuous operational attention from the agencies' staff.

Despite the stark differences in operational requirements among these systems, they all perform the same task: providing real-time transit information to the customers. Hence, agencies procuring these systems should closely study the operational needs of the various systems available. Agencies with very limited operations staff or funds may decide to select a system that does not require much involvement on their part. On the other hand, agencies that want to have complete control of every aspect of the system, and have the adequate staff and resources to do so, may choose to acquire a system that provides easy agency access (potentially through system customization).

### 5.4.2 Addressing Communications Issues

Some of the first problems encountered in full deployment of real-time traveler information systems often involve communications. Problems that arise include inadequate channel capacity, dead spots where no communication signal is received, and inadequate speed. Over the long term of O&M, the cost of communications, in some instances, also may become an issue. With the right planning and technical expertise, an agency should be able to avoid these problems. Involving the agency's department that is responsible for communications (e.g., information technology) in the project and acquiring internal and external ITS expertise will help solve these problems. This will provide a solid basis for assessing the agency's communications capabilities and requirements, and will likely provide alternatives to costly wireless options.

> **Acquiring internal and external ITS communication expertise will avoid some of the first problems that show up: inadequate channel capacity, speed and dead spots**

One agency interviewed that provides arrival times at a number of train stations complained about the speed of data transmission. Its current 56 kilobits-per-second speed makes sending ad hoc messages from the central control to their DMSs at train stations very inefficient. Moreover, it hinders their efforts to provide ad hoc audio announcements. Consequently, when the system sends an ad hoc text message to the signs on incidents or unexpected delay, the staff avoids sending an audio message. The communication speed has affected the way this agency operates its real-time system in the sense that ad hoc messages are sent only when it is necessary. This situation prompted staff to stop sending ad hoc audio messages.

Communications coverage also was an issue for River Valley Transit. The original number of spread-spectrum antennas deployed at the transit center proved insufficient to communicate with all buses as they travel around the transfer center. This short-range communications method requires a substantially clear line of sight. River Valley Transit was able to address this issue by adding antennas at various locations, but it was not aware of the problem until the system was operational.

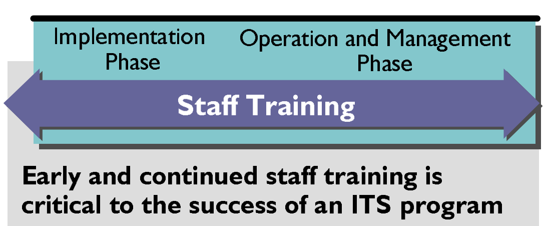
Another agency had a different kind of communications coverage problem. This agency's system uses cellular technology for the communication of location data. The system sends GPS data to the central computer using CDPD technology via a frame-relay connection. Unfortunately, some parts of the service area do not have cellular service; only 50 to 60 percent of the area is currently covered. This agency is developing a new approach using a cellular telephone communications provider, which will provide at least 90 percent coverage. The agency will implement this new approach by June 2003.

The ongoing communications cost issue, in particular, is critical since substantial portions of an investment could end up being lost. A few of the agencies interviewed that are providing real-time arrival information on DMSs via CDPD have complained that the cost of communications is high. One agency is considering switching its current system from CDPD to a cheaper alternative. Agencies sometimes underestimate the ongoing cost of communications and must consider this cost in the O&M budget.

### 5.4.3 Providing Training

Training staff on newly procured systems is a critical step in ensuring that the system operates as intended. Staff training should begin before the implementation stage and continue throughout the O&M phase. No system is capable of running by itself without periodic updating, and hardware and software maintenance. In turn, making sure that trained staff is always available helps the agency reap the benefits of the system, and strengthens the customers' trust in the agency.

If an agency plans to maintain the system in-house rather than outsourcing, then staff should be able to handle hardware and software diagnosis and replacement. System administrators who will take part in maintaining the system will require separate training that will enable them to maintain the software and associated databases. Obtaining complete and well-documented maintenance manuals is also important for continued operation of the system. One agency stated that it is not satisfied with the maintenance manuals for its real-time traveler information system. For the most part, the manuals have been too vague, making it difficult for staff to maintain the system effectively and efficiently.




Staff who will be operating the system also will need initial and ongoing training. The agency should not limit the training to operations; drivers and system administrators will benefit from training as well. Most systems require drivers to log on to the system before operating their routes/runs. Some systems require the drivers to enter only their ID number, while other systems require that they enter the bus number and route/run number as well. In either case, if the driver does not log on, or enters the wrong information, the bus will not generate useful location data, as the system may not collect any data or provide inaccurate arrival/departure times. This has been a problem for some agencies in the United States as well as in Europe. Fairfax City-University-Energysaver (CUE) Bus System experienced some of this in the beginning as drivers occasionally forgot to log on to the system. However, Fairfax CUE's drivers have been very cooperative, and with some additional training and reminders, they were able to overcome this problem.

Two real-time information systems in England—Countdown in London and Timechecker in Liverpool—also experienced the same problem as Fairfax CUE. Both systems provide real-time bus arrival information at bus stops via DMSs. Some operators were not logging on to the system, so there were impacts on the accuracy and reliability of the data the system generated. In the case of Countdown, the signs were not displaying up to 15 percent of the vehicles. One of the solutions considered by the agency was to link the bus radio to the on-board electronic ticket machine to assist driver log-in.[19] Transport for London did use this solution for the Countdown system, and it has proven effective.

Customer service staff also should receive adequate training on the system. Many agencies provide their customer service staff with computer access to the real-time information since they interact directly with the customers. Therefore, including customer service staff in the training program is required.

Finally, it is important to keep in mind that "training provided by the vendor should be structured for maximum effectiveness. Complete documentation on all aspects of the equipment is essential to ensure that the agency can continue training once the vendor completes its responsibilities. Agencies should consider training a set of its top employees to serve as trainers."[20]

### 5.4.4 Maintaining the System

The importance of maintenance in real-time information systems lies in the intent of the system to provide real-time information, not archived or static information. Customers using these systems expect to have readily available accurate and reliable information. Therefore, any maintenance issue that would cause the dissemination of inaccurate information, or no information at all, would quickly

[19] *"Review of Current Passenger Information Systems,"* Infopolis 2, Deliverable 1, 1998.

[20] Schiavone, John, "Understanding and Applying Advanced On-Board Bus Electronics," TCRP Report 43, TRB, Washington, 1999, p. 93.

erode the customers' trust in the system and, in turn, the agency. Skybus[21] in Copenhagen, Denmark, confirms that a good service agreement is necessary for successfully operating a real-time information system and for maintaining its data reliability and integrity.

RECOMMENDED PRACTICES

Many agencies recommend developing maintenance support agreements with vendors or developing the necessary in-house expertise to handle hardware and software maintenance. Some agencies may elect to have agreements with their vendors, but also have part-time staff with technology support as their primary responsibility. This approach may work better than relying solely on the software or hardware vendor because it enables more rapid problem solution.

UNIQUE APPLICATION

Another sound approach to maintenance issues is to document problems in a report format. River Valley Transit uses Problem Identification Reports. The agency uses these four-page forms to identify problems quickly so that they can be resolved quickly. Any employee can file a Problem Identification Report, including maintenance and operations personnel. The report requests the following information:

- Time and date of the problem occurrence
- Equipment affected
- Description of the problem
- Other unusual system occurrences prior to experiencing the problem
- Other functions being performed at the time
- Attempts to fix the problem.

The form is diagnostic in nature, and steps the individual through a number of system tests and possible solutions. The report system asks the individual to record the results of the diagnostic tests and then submit the report so that it can be filed for future reference and possible system changes.

The vendor that supplied the real-time system has been providing telephone support to answer operational questions and, based on the formal master list of problems, has met with River Valley Transit to review the list and discuss how issues can be resolved. Once the vendor implements a solution, the vendor meets with the River Valley Transit staff to demonstrate the new features. For example, after the initial installation, drivers were able to turn off the MDTs. Consequently, the vendor reprogrammed the units to disable the on/off switch. The ongoing problem identification and communication between River Valley Transit and the vendor is an example of a good relationship that should exist between the agency and the vendor to ensure that the system will continue to operate smoothly. This relationship has been key to the success of the traveler information system project and is evidence that agencies should pay specific attention

[21] Pallett, Kevin and Peter Sonne, "Skybus - Copenhagen and Showcase - Centro Real Time Information Systems," *Proceedings of the 8th World Congress on ITS*, Sydney, Australia, September 30 – October 4, 2001.

to the vendor's ability to provide ongoing support and to be responsive to the agency's needs.[22]

### 5.4.5 Adding Staff

Another area that affects O&M as well as the overall agency's budget and personnel is adding new staff members to support the operation of the real-time traveler information system. A small agency that deploys a real-time traveler information system that has very limited functions and operates on a very limited basis may be able to operate and maintain the system without adding new staff. However, for the most part, real-time systems will require the agency to hire new staff to operate the system and may need to add staff to affected departments, such as information technology, operations, maintenance, and customer service.

Denver Regional Transportation District added two full-time staff to the information technology department to handle providing real-time information. One person writes applications to maintain the Oracle database used by the real-time applications and the other manages a consultant's work to maintain the system and to address other system-related issues.[23]

Cape Cod Regional Transit Authority had to hire new staff after implementing its real-time information system. The system generates a large volume of data, and the agency did not account for this initially. The agency was unsure of how to use the data most effectively so it hired a data analyst who is responsible for monitoring the data and creating reports for operations and project management.

In Washington Metropolitan Area Transit Authority's case, the agency had to hire a number of new employees to maintain its PIDs. The agency added new staff in the operations control and passenger operations areas, in addition to one engineer and five technicians in the field.

## 5.5 Marketing

Agencies should market real-time traveler information systems to make customers aware of the system. The agencies interviewed for this project market their systems. Unfortunately, most of the agencies were not pursuing the marketing effort vigorously or conducting a targeted marketing campaign.

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[22] Multisystems, with KFH Group, *Rural Transit ITS Best Practices*, prepared for the ITS Joint Program Office, Draft Report, August 12, 2002, pp. 7-12.

[23] Schweiger, Carol, *Real Time Bus Arrival Information Systems,* TCRP Synthesis SA-14, Draft Report, October 2002.

Transit agencies understand the importance of marketing their services, whether fixed-route or demand-responsive services, schedules, route alignments, or addition/termination of routes, and they spend a significant amount of their funds and staff time to carry it out. Most transit agencies have a marketing department to promote the agency's services. Thus, it is surprising that these agencies do not market their real-time traveler information systems using the same marketing effort that they direct for their transit services. After all, a real-time traveler information system is a *service* that the agency provides to its customers to improve their mobility and enhance their transit experience.

RECOMMENDED PRACTICES

As real-time traveler information systems operations continue to become more sophisticated, they will require appropriate marketing strategies. Until very recently, real-time information consisted of displaying the arrival times on a DMS at a bus shelter or train station. This did not require much marketing as passengers generally noticed and understood the signs. However, it is important for customers to recognize that the signs display real-time information rather than scheduled information. Further, real-time information systems are using more dissemination media than DMSs, such as the Internet, kiosks, cellular telephones, pagers, PDAs, and e-mails. If customers do not receive information about these dissemination media, they may not become aware of the service and, consequently, they will not use it.

**Market real-time traveler information systems to:**

- Make customers aware of the system
- Show the variety of dissemination media accessible to customers
- Explain the objectives, goals, and benefits of the system
- Increase visibility of transit in the community
- Increase ridership and revenue

An agency deploys real-time traveler information systems to achieve certain objectives and goals, which most often include improving customers' transit experience and safety, providing a more reliable transit service, increasing ridership and revenue, and increasing the visibility of transit in the community. The real-time traveler information systems cannot meet these objectives if the intended users are not using the deployed systems. Therefore, marketing this *service* becomes a critical factor in meeting these goals and objectives.

As stated earlier, most of the agencies interviewed did market their systems primarily through the Internet and press releases, followed by mention in the agencies' newsletters. Although press releases play a positive role in introducing the new system to the public, they tend to have a very short life. Marketing the system on the agency's web site provides longer-term visibility and an ongoing marketing campaign. The new web site should prominently display the real-time traveler information systems, and customers should be able to access it easily. Other methods used by some agencies to market the new service include printed brochures on-board buses, trains and ferries, and, in one instance, printed schedules.

RECOMMENDED PRACTICES

Azienda Trasporti Consorziali in Bologna, Italy, provides an example of an elaborate and targeted marketing campaign for real-time traveler information systems. Azienda Trasporti Consorziali's real-time system includes an option whereby customers can receive real-time bus arrival via cellular telephones (called "hellobus"). Azienda Trasporti Consorziali and the cellular telephone provider did a significant amount of marketing in an effort to inform the public. Visitors to the agency's web site (www.atc.bo.it) find an entire page dedicated to the system (www.comunicazione.vodafoneomnitel.it/iniziative/cittadini/hellobus/hellobus.asp).

Transit customers' reactions reinforce the importance of marketing. Tri-Met's Transit Tracker system provides real-time transit information through two types of media, the Internet and LED signs at stops and stations. In a survey conducted in 2002, Tri-Met found that 65 percent of the survey respondents knew that the time displayed on the DMSs was real-time; and the value placed on having Transit Tracker at their bus stop was, on average, 4.5 on a scale of 1 to 5, with 5 representing the highest possible value[24].

In the case of Washington State's Vessel Watch system, survey responses were very positive as well. Vessel Watch is an Internet application that allows the customers to see where their vessel is. Customers also can sign up to receive e-mail notifications about delays and/or service disruptions. Not only were customers' responses to the new system very favorable, but the agency was also able to cut the number of telephone calls to its customer information service by 30 percent between 1998 and 2000. This translated into $62,000 savings in call-center telephone bills.

The customer satisfaction examples cited above indicate that transit customers are indeed using the deployed real-time traveler information systems. This means that real-time traveler information systems are providing a valuable service to customers. Therefore, with better marketing approaches and campaigns, transit agencies will be able to reach more of the public to educate them about the real-time traveler information systems. With better-informed customers using the new service, these projects are more likely to meet their objectives and goals.

## 5.6 Business Models

The subject of business models was not a topic of significant discussion during interviews with the participating transit agencies. The limited response to interviewer questions reinforces that transit is not investigating potential business models before deploying real-time traveler information systems.

Before addressing the two business models relevant to deploying real-time traveler information systems, it is important to understand current business

[24] "Transit Tracker Evaluation," Tri-Met Marketing Information Department, June 2002.

practices for ATIS services. There is a significant amount of literature about the business case for ATIS. Two studies[25] [26] reviewed in the initial phase of this document's development evaluated the public's willingness to pay for real-time transit information. Both studies showed that a majority of passengers would be willing to pay for real-time transit information if they found value in it. Results of a San Francisco Bay Area survey conducted in 1999 revealed that, of those who said they get traffic or transit reports from various sources, 17 percent would prefer to pay monthly for real-time information, 56 percent would prefer to pay on a per-call basis, 22 percent would not use the service for a fee, and 5 percent were unsure.

A case study on SmarTraveler, an ATIS that provides real-time location-specific traffic and transit information in the greater Boston area via telephone, reveals that, for non-users of SmarTraveler, the higher the expected benefit from an ATIS (i.e., reliability, relevance, coverage), the higher their willingness to pay. For users, the utility of SmarTraveler is strongly affected by the users' level of satisfaction with the service[27]. That is, as long as they continue to be satisfied with the service they are using and the information they are obtaining, they are willing to pay for it.

Overall, several business model studies[28] have revealed the following about providing ATIS services:

- **Public funding, especially for data collection, is essential to a successful ATIS implementation.** Any initiative that increases the availability of quality data should be a priority.

- **The public sector may have the opportunity to sell its data, as long as the data are high quality and the private sector cannot gather similar data on its own.** However, the value of such data is likely to be relatively low at present and for the near future. An agency is unlikely to be able to support its transit ITS investments with private sector revenue.

- **Revenue generation from ATIS services, both wholesale and to the individual, has not proven to be able to support an ATIS service wholly.** There may be new models and new ventures determined to prove this model viable, but they are unproven at this time.

- **If public agencies in a region or state have specific traveler information services they would like to provide to their traveling public, they should be**

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[25] Wolinetz, Louis, Asad Khattak, and Y. B. Yim, *"Why will some Individuals Pay for Travel Information when it can be Free?: Analysis of a Bay Area Travel Survey,"* Transportation Research Board, paper # 01-2969, 80th Annual Meeting, Washington, D.C., January 2001.

[26] Polydoropoulou, Amalia, Dinesh Gopinath, and Moshe Ben-Akiva, "*Willingness toPpay for Advanced Traveler Information Systems,"* Transportation Research Record 1588.

[27] Ibid

[28] Rick Schuman and Eli Sherer, *ATIS U.S. Business Models Review*, prepared for the US DOT ITS Joint Program Office, November 15, 2001.

**prepared to underwrite most or all of the cost.** Although it may be possible to provide such services free of charge as part of a partnership model, the literature indicates that these services do not evolve to the level of quality and use desired by the public sector unless they are either operated in-house or contracted on a fee-for-service basis.

Key results of research conducted for the United Kingdom as part of the Transport Direct project suggest the following about business models[29]:

- Investment in information services is a long-term commitment and it is not without significant risks, particularly when there is limited evidence that information services will generate enough demand to cover costs.
- The mere presence of public transportation information will not make the service a success. Success hinges on the following aspects of a service:
  - Political commitment
  - Healthy commercial environment for operators
  - Appropriate technological infrastructure
  - Stimulus for consumers' demand and for the market to encourage the provision of these types of systems
- Investment in real-time traveler information systems services is not a substitute for investment in other public transportation improvements. Information should be considered complementary to investment in public transportation.
- There is a need for public authorities to provide substantial capital investments to establish these systems and the necessary infrastructure. This assumes that the private sector will operate the service commercially.
- An information service should not be assumed to operate in isolation or confine itself to traveler information.
- There is a need to identify the potential impact of an information service on behavior before considering development and deployment.

These general tenets appear throughout the literature. The Real-Time Information Group[30], in discussing a national strategy for British transit agencies, emphasized the importance of partnerships—public-public and public-private. Partnerships with other public agencies (transit or traffic) will allow transit agencies to share

RECOMMENDED PRACTICES

[29] Glenn Lyons, Reg Harman, John Austin and Alastair Duff, "Traveller Information Systems Research: A Review and Recommendations for Transport Direct," August 2001, prepared for Department for Transport, Local Government and The Regions, London, UK, pp. 20-23.

[30] Real Time Information Group, "A National Strategy for Real Time Information," draft report, obtained from INFORM, the Public Transport Informatics Group in the U.K. operated by Transport & Travel Research Ltd.

real-time data and thus respond to issues and service disruptions more promptly. The Group recommends adapting the organizational approach first established for PTI2000,[31] which has demonstrated effective collaboration between authorities' operators and suppliers. The principle underlying the model is to separate out the project risk structure so that those risks that are better managed by the private sector are transferred to the private sector, and those that are better managed by the public sector remain under public sector control.

CAUTION

The Seattle MMDI Integration Case Study[32] indicated that it would take more than forming partnerships to get the private entities involved. The document speculated that few private entities contribute data because they view data as competitive, business-sensitive information that they are not inclined to share without compensation or appropriate data-ownership agreements. The UK Real Time Information Group proposed establishing formal data-sharing agreements for all service delivery and information partnerships. Such agreements would address intellectual property rights issues for performance data, limitations on use, and transfer of information between parties.

Overwhelming evidence indicates that agencies have not rigorously explored the use of information services business models. Further, it is not clear that any of the models identified in the research would work for transit agencies providing real-time traveler information systems. However, two currently used models do demonstrate some degree of success.

**The ASP business model offers one way for vendors and transit agencies to provide a real-time information service.**

One vendor in particular provides a real-time information service, rather than selling the infrastructure to an agency for the agency to operate. They consider themselves an application service provider (ASP) that provides operating software that runs on the vendor's servers, monitors system operations from their facility, and provides secure access to the real-time information from their Internet web site. As of December 2002, 20 agencies had purchased this service.

CAUTION

One issue that has surfaced with respect to this model is "who owns the data?" The vendor usually claims to own the data, but San Francisco Municipal Railway, which recently procured this service for their entire system, insisted that San Francisco Municipal Railway owns the data. While the vendor uses data describing agency operations (e.g., location data), installs all the system's equipment (both in-vehicle, at central dispatch, and at vehicle stops/stations), and operates the signs for a service and contract fee, San Francisco Municipal Railway wanted to maintain ownership of the data. If the vendor plans to use these

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31 Public Transport Information 2000 (PTI2000) is a document outlining a strategy for regional and national cooperation among transit agencies.

32 Collura, John, James Chang, and Mark Carter, "Seattle MMDI Integration Case Study: ATIS and the ITS Information Backbone," 79th Transportation Research Board Annual Meeting, January 2000.

data, adds value to them, and resells them in any other way, the vendor will have to obtain San Francisco Municipal Railway's approval to do so. Further, the vendor's proprietary system provides the main processing and dissemination of the real-time arrival information and it is stored on the vendor's servers, but it is backed up on the agency's computers on a daily basis. The vendor is also required to store the data for 14 days.

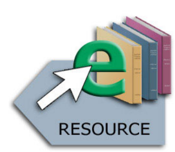

Denver Regional Transportation District is using another business model. A commercial Internet Service Provider (ISP) uses Denver Regional Transportation District data to alert customers about real-time information at as many as two stops per route (two routes are allowed) at a particular time of day. Denver Regional Transportation District has an agreement with them to use the Denver Regional Transportation District real-time data to generate the alerts. Customers also can sign up for traffic alerts at the same web site. All of the ISP's services are currently free to the user.

Virginia Railway Express has a policy about sharing data that does not allow for modifications to the data, requiring that information that is published or displayed must match the information posted on Virginia Railway Express's Internet web site. This is simply to prevent confusing the rider with contradictory information.

## 5.7 ITS Architecture and Standards


The National ITS Architecture (the Architecture) was developed by the United States Department of Transportation (USDOT) to facilitate seamless, integrated deployment of intelligent transportation systems across the United States. The Architecture supports a structured, systematic analysis of transportation problems and issues and provides a framework for providing technological solutions to these local, regional, and national transportation issues.

The USDOT provides numerous resources to familiarize, educate, and direct users on the details of the Architecture. Many of these sources are available on the Internet and through published guidance and technical resource documents published by the USDOT, FTA, and other organizations. Examples of these resources include the following:




- U.S. Department of Transportation web site (www.dot.gov)
- National ITS Architecture web site (www.its.dot.gov/arch/arch.htm or http://itsarch.iteris.com/itsarch)
- Standards web site (www.its-standards.net)

- Regional ITS Architecture Guidance document (www.its.dot.gov/arch/arch.htm)
- Transit ITS (www.fta.dot.gov/research/fleet/its/its.htm)
- FTA National ITS Architecture Consistency Policy, Additional Grantee Guidance www.fta.dot.gov/office/research/itstp2003.html.

In addition to using these reference materials, transportation professionals may access many USDOT-sponsored educational opportunities to become familiar with the details associated with the content, use, and application of the National ITS Architecture. In particular, the FTA, through the National Transit Institute, has sponsored the development of a course on complying with the FTA policy on consistency with the National ITS Architecture (www.ntionline.com/CourseInfo.asp?CourseNumber=ITS02). This course focuses on what transit agencies are required to do to comply with the FTA's policy on the National ITS Architecture.

**Real-time traveler information systems should be consistent with the National ITS Architecture and FTA policy.**

Deploying real-time traveler information systems in a transit application *is* deploying ITS technologies. Transit agencies considering the deployment of new (or expansion of existing) real-time traveler information systems will be required to show that these deployments are consistent with the Architecture and meet the requirements of FTA's policy on consistency with the Architecture. Although the USDOT has been developing the Architecture for the past 10 years, the specific requirements have been in place only since April, 2001, in the form of the FTA policy and the Federal Highway Administration regulation for transit operators to use and comply with the Architecture.

RECOMMENDED PRACTICES

Transit providers who are beginning to consider the deployment of a real-time traveler information system should consult with their regional FTA representative, local planning organizations, and other transportation providers in their area or region to determine if there is a local/regional architecture in place. If there is a regional architecture in place, those responsible for developing and maintaining that architecture should be able to assist in the proper application of that architecture to the planned technology program.

At a minimum, an agency needs to identify how the proposed real-time traveler information system "fits into" that architecture and which pieces or services of that architecture the agency is providing. This involves a systematic analysis of the project to determine the needs being addressed (i.e., lack of real-time information for travelers to know when the transit vehicle will be arriving at a particular location) and the proposed technological solution. In addition, it will involve identifying how (and if) information will be shared between the real-time traveler information system and other ITS systems in the areas such as freeway management, emergency response agencies, and other transit providers. This does not have to be an arduous task, but there are specific requirements that must be met in order to receive Federal funding for the project with respect to how the system is defined, implemented, and integrated into the region's overall ITS "network." These requirements are specified in the FTA policy on consistency with the National ITS Architecture (referenced above). If the area or region does not currently have an architecture in place, the agency still must adhere to the FTA architecture policy requirements in order to receive Federal funding for the program.

In addition to identifying the specific physical components of the system and how they will work and interact internally and externally with other transportation systems in the area/region, an agency must identify which (if any) ITS standards are applicable for its system and which will be used/implemented. In this case, standards represent the exact form and content of the information that will be shared within a specific ITS system as well as data/information that will be shared outside the system. The USDOT is sponsoring the development of a full suite of ITS standards that support the National ITS Architecture (see Standards web site referenced above). These standards spell out specifically how data are to be defined, packaged, and shared between and among ITS systems. Just as standards have facilitated the interoperability of home entertainment equipment, implementation and deployment of ITS systems using common standards for communication and data sharing will greatly enhance the interoperability and interchangeability of systems across the country. Table 5-1 lists the applicable standards for real-time traveler information systems including the standard developing organization (SDO) and the status of various standards. Additionally, specific information on bus standards and the Transit Communication Interface Profiles (TCIP) suite of standards is also available on the American Public Transportation Association (APTA) web site at www.apta.com.

RESOURCE

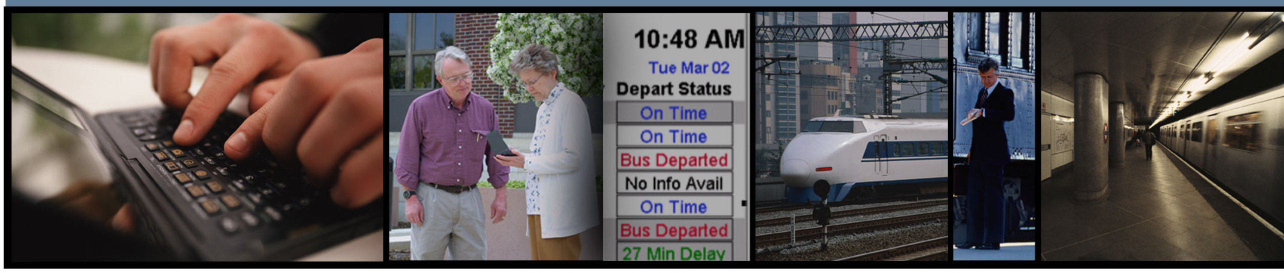
The implementation of ITS systems using common standards will benefit both the transit riders as well as the providers of transit services throughout the country. The riders will benefit by having a common platform of services, allowing portability of devices among transit providers. For example, a transit rider in the Seattle area who receives real-time traveler information on her PDA during her daily commute potentially could use that same PDA to receive real-time traveler information while vacationing and using public transit in the New York City area.

Transit providers across the country will benefit from the economies of scale realized by the private sector vendors of ITS equipment and services. Vendors will be able to develop their systems around a "common platform" of communication standards instead of having to customize those services for each specific location. By having common communication and interface requirements, transit agencies will be less likely to depend on the services of a proprietary, closed system that can be accessed only by a single vendor. They will be able to "mix and match" systems and services offered by many different vendors, much in the same way consumers can now mix and match the various components of a home entertainment system, without concern over who manufactures each component.

**Table 5-1. Applicable Standards for a Real-Time Traveler Information System**

| SDO | Applicable Standards | Status |
|---|---|---|
| National Transportation Communications for ITS Protocol (NTCIP) Joint Committee (ITE, NEMA, and AASHTO) | 1101 - Simple Transportation Management Framework (STMF) | Published April 1997 |
| | 1102 - Octet Encoding Rules (OER) | Approved August 2002; awaiting publication |
| | 2202 - Internet Transport Profile (TCP/IP and UDP/IP) | Published March 2002 |
| | 2301- Application for Simple Transportation Management Framework (STMF) | Published March 2002 |
| | 2302 - Application Profile for Trivial File Transfer Protocol (TFTP) | Published March 2002 |
| | 2303 - Application Profile for File Transfer Protocol (FTP) | Published March 2002 |
| | 2304 - Application Profile for DATEX-ASN | Approved August 2002; awaiting publication |
| | 2305 - Application Profile for Common Object Request Broker Architecture (CORBA) | Under development; In "user comment draft" |
| Society of Automotive Engineers (SAE) | J2353 - Data Dictionary for ATIS | Published April 2000 |
| | J2354 - Message Set for ATIS | Published October 2000 |
| | J1708 - Serial Data Communications Between Microcomputer Systems in Heavy-Duty Vehicle Applications | Published October 1993 |
| | J1939 – Recommended Practice for a Serial Control and Communications Vehicle Network | Published April 2000 |
| | J2496 – Transit Area Network Cabling Standard | Published March 2000 |
| | J1587 - Electronic Data Interchange Between Microcomputer Systems in Heavy-Duty Vehicle Applications | Published February 2002 |
| | J2374 - Location Referencing Message Specification | Published July 1999 |
| | J2366-1 – ITS Data Bus -Idb-C Physical Layer | Published November 2001 |
| | J2366-2 – ITS Data Bus – Link Layer | Published November 2001 |
| | J2366-4 – ITS Data Bus – Thin Transport Layer | Published March 2002 |
| | J2366-7 – ITS Data Bus – Application Message Layer | Published April 2002 |
| Institute of Transportation Engineers (ITE)* – Transit Communication Interface Profiles (TCIP) | 1400 – TCIP Framework Standard | Published January 2002; Amendment 1 under development |
| | 1401 – TCIP Common Public Transportation (CPT) Objects | Published April 2001; Amendment 1 under development |
| | 1403 – TCIP Passenger Information (PI) Business Area Standard | Published April 2001; Amendment 1 under development |
| | 1404 – TCIP Scheduling/Runcutting (SCH) Business Area Standard | Published April 2001; Amendment 1 under development |
| | 1405 – TCIP Spatial Representation (SP) Objects | Published April 2001; Amendment 1 under development |
| | 1407 – TCIP Control Center (CC) Objects | Published January 2002; Amendment 1 under development |
| Institute of Electrical and Electronics Engineers (IEEE) | P1488 – Trial Use Standard for Message Set Template for ITS | Published July 2000 |
| | P1489- Data Dictionaries for ITS | Published December 1999 |

* APTA is developing dialogs to build off the data and message set standards.




# 6 Looking Ahead

As discussed earlier, the USDOT and FTA have strongly supported the development, adoption, and use of the National ITS Architecture. Part of that ongoing support is the continued development and testing of the various communication standards (e.g., TCIP, NTCIP). Although the FTA National ITS Architecture Policy on Transit Projects requires eventual compliance with all the formally adopted transit standards, as of the date of this guidance document, none of these standards has reached the point where implementation is required since they have not been tested and formally adopted by USDOT. Moving these standards forward will be a key focus of FTA's transit activities over the coming years. As transit agencies design, deploy, and operate real-time traveler information systems, the use of these communication standards will help to simplify the deployment and provide a measure of consistency and interchangeability among different transit ITS applications. FTA is currently working with the American Public Transportation Association to conduct pilot implementations of real-time traveler information systems using the TCIP data, message set, and dialog standards. At the end of the pilots, lessons learned, sample procurement, and standards implementation for passenger information systems will be available.

In addition, advances in technology applications will have an impact on the types of real-time traveler information systems deployed in the transit community. As of December 2002, the technology is migrating toward the use of XML and the Internet as the "backbone" of many of the real-time traveler information systems. Penetration of mobile telephones, hand-held PDAs, and other wireless communication devices continue to change the way today's travelers interact with their surroundings. Within just the past few years, technology advances have enabled agencies to provide personalized, real-time traveler information directly to the transit rider while the rider is on the transit vehicle. Continued improvements in these technologies (faster communication, better coverage, greater capability to handle video and pictures) will drive the real-time traveler information applications of the future.

Advances in the transit industry also will drive the deployment of real-time traveler information systems. The stronger emphasis on customer-oriented services and on attracting choice riders (those who have other means of commuting) will influence agencies that are considering technology deployment to make real-time traveler information systems a priority. Literature indicates that real-time traveler information system deployment does result in an increase in ridership, as well as an increase in transit's visibility and customer perception in a region. In the future, more market research that focuses on customers' needs for real-time traveler information systems likely will be conducted along with traditional market research about transit service satisfaction to determine the type of real-time traveler information systems that would be most beneficial to current and potential riders. Progressive transit agencies that have shifted their focus to the customer are already conducting this type of market research.

Many regions will consider and deploy real-time transit information integrated with other traveler information. With the advent of 511 and Internet-based traveler information systems, customers seeking multimodal information are interested in "one-stop shopping." Real-time transit information undoubtedly will add value to regional traveler information, and will potentially influence travelers to consider transit when they may, in the past, have not considered it as an alternative. For example, many travelers, particularly in Europe, have expressed an interest in receiving travel-time information for all modes in a region. Traditionally, travel times are provided only for driving, and consequently, many travelers do not view transit as an alternative. However, in the future, being able to compare transit travel time side-by-side with driving travel time may attract travelers to transit.

# Appendix A

# List of Participating Transit Agencies

# LIST OF TRANSIT AGENCIES AND CONTACT INFORMATION

| Agency Name and Location | Contact Information |
|---|---|
| Cape Cod Regional Transit Authority (CCRTA)<br>Dennis, Massachusetts | **Dennis Walsh**<br>Assistant Administrator<br>Cape Cod Regional Transit Authority<br>585 Main Street<br>Dennis, MA 02638<br>Ph: 508-385-8311<br>e-mail: dwalsh2@mediaone.net |
| Northeast Illinois Regional Transportation Authority (RTA)<br>Chicago, Illinois | **Gerry Tumbali**<br>Regional Transportation Authority<br>175 West Jackson Blvd<br>Suite 1550<br>Chicago, IL 60604<br>Ph: 312-913-3251<br>Fax: 312-917-0846<br>e-mail: tumbalig@rtachicago.org |
| Denver Regional Transportation District (RTD)<br>Denver, Colorado | **Gary Googins**<br>IT Programmer / Analyst<br>1900 31st Street<br>Mail Stop: DO-M2<br>Denver, CO 80216-4909<br>Ph: 303-299-6116<br>e-mail: gary.googins@rtd-denver.com |
| Fairfax CUE<br>Fairfax, Virginia | **Alex Verzosa**<br>Transportation Director<br>City Hall, City of Fairfax<br>10455 Armstrong Street<br>Fairfax, VA 22030<br>Ph: 703-385-7889<br>Fax: 703-385-7863<br>e-mail: averzosa@ci.fairfax.va.us |
| Jacksonville Transportation Authority (Skyway)<br>Jacksonville, Florida | **Steve Arrington**<br>Director of Engineering<br>Jacksonville Transportation Authority<br>PO Drawer O<br>Jacksonville, FL 32203<br>Cell phone: 904-630-3108/3119 (direct)<br>Fax: 904-630-3166<br>e-mail: stevea@jtaonthemove.com |

| Agency Name and Location | Contact Information |
|---|---|
| King County Metro<br>Seattle, Washington | **Thomas Friedman**<br>201 S. Jackson<br>KSC-TR-0333<br>Seattle, WA 98104<br>Ph: 206-684-1513<br>e-mail:<br>TOM.FRIEDMAN@metrokc.gov |
| Los Angeles Department of Transportation (LADOT)/Los Angeles County Metropolitan Authority Metro Rapid (LAMTA)<br>Los Angeles, California | **Kang Hu**<br>Transportation Engineer<br>Los Angeles Department of Transportation<br>200 N. Main St.<br>ATSAC Center – CHE P4, MS 759<br>Los Angeles, CA 90012<br>Ph: 213-977-8523<br>Fax: 213-580-5180<br>e-mail: Khu@dot.lacity.org |
| Metra (Chicago Commuter Rail)<br>Chicago, Illinois | **Sharon Austin**<br>Chief Communications Officer<br>547 W. Jackson Blvd<br>Chicago, IL 60661<br>Ph: (312) 322-6513<br>e-mail: saustin@metrarr.com |
| River Valley Transit (formerly CityBus)<br>Williamsport, Pennsylvania | **John Kiehl, Jr.**<br>Operations Manager<br>1500 W. Third Street<br>Williamsport, PA 17701<br>Ph: 570-326-2500<br>e-mail: jkiehl@citybus.org |
| San Francisco Municipal Railway (MUNI)<br>San Francisco, California | **John Funghi**<br>Project Manager (NextBus)<br>1145 Market Street<br>San Francisco, CA 94103<br>Ph: 415-554-1792<br>e-mail: john_funghi@CI.SF.CA.US |
| San Luis Obispo (SLO) Transit<br>San Luis Obispo, California | **Austin O'Dell**<br>Transit Manager<br>San Luis Obispo Transit<br>955 Morro Street<br>San Luis Obispo, CA 93401<br>Ph: 805-781-7121<br>e-mail: aodell@slocity.org |

| Agency Name and Location | Contact Information |
|---|---|
| Tri-County Commuter Rail<br>Pompano Beach, Florida | **Don Livernois**<br>Budgets and Grants Manager<br>800 NW 33rd Street, Suite 100<br>Pompano Beach, FL 33064<br><br>Ph: 954-942-7245<br>Fax: 954-788-7878<br>e-mail: livernoisd@tri-rail.com |
| Tri-County Metropolitan Transportation District of Oregon (Tri-Met)<br>Portland, Oregon | **David T. Crout**<br>Planner/Analyst<br>Tri-Met<br>4012 SE 17th Ave., M.S. HPD2<br>Portland, OR 97202-3993<br><br>Ph: 503-962-5613<br>Fax: 503-962-3088<br>e-mail: croutd@tri-met.org |
| Virginia Railway Express (VRE)<br>Alexandria, Virginia | **Don Chism**<br>Manager, Information Technology<br>Virginia Railway Express<br>1500 King Street<br>Suite 202<br>Alexandria, VA 22314<br><br>Ph: 703-684-1001<br>Fax: 703-684-1313<br>e-mail: dchism@vre.org |
| Washington Metropolitan Area Transit Authority (WMATA)<br>Washington, D.C | **Will Raine**<br>WMATA<br>1550 Wilson Blvd<br>Suite 300<br>Arlington, VA 22209<br><br>Ph: 703-945-1121<br>e-mail: wraine@wmata.com |
| Washington State Ferries (WSF)<br>Seattle, Washington | **Susan Harris-Huether**<br>Customer Information Manager<br>Washington State Ferries<br>2911 Second Ave<br>Seattle, WA 98121-1012<br><br>Ph: 206-515-3460<br>e-mail: sharris@wsdot.wa.gov |

# Appendix B

# Telephone Interview and Site Visit Summaries

| Transit Agency: | **Cape Cod Regional Transit Authority (CCRTA) – Dennis, Massachusetts** |
|---|---|
| **Real-time Transit Information System** | **Advanced Travel Planner** |

**Description of the Real-time Transit Information System**

The real-time transit information system implemented by Cape Cod Regional Transit Authority is an Internet application (www.thebreeze.info) that provides information on the location of the Cape Cod Regional Transit Authority buses by tracking them and displaying their real-time location on a map. The real-time vehicle location is collected from the buses through a GPS receiver, which is part of their integrated MDT/AVL system. The buses are represented as arrows on the map (directional) when moving, and as circles when they are stopped. The bus routes are represented by thick colored lines. To get information on any of the icons on the map, there is an Info button that, when selected, presents a pop-up screen with detail on the routes and the stops.

There is an option to select/zoom into an area based on the origin and destination that a user is interested in. The user can choose to view a specific area of the map by entering addresses or common names for an origin and destination. Once the selection is made and "Return to Map" is clicked, the map will automatically zoom in to an area surrounding at least one and a half miles around all the chosen points of interest. The page (map overview) is automatically refreshed every 90 seconds.

The Internet application was developed by the Moakley Center for Technological Applications of the Bridgewater State College. The key person involved in developing this application was also the project manager for the procurement of the MDT/AVL system for Cape Cod Regional Transit Authority.

The Moakley Center staff is also working on a prediction algorithm that will take the AVL data from the buses and display the next bus arrival information on a LED sign. This was tested in summer 2002 and displayed on a sign at the Hyannis Port Main Terminal.

**Types of Information Provided (include current and planned)**

The real-time information presented by the advanced travel planner includes the location of the buses on the map, and the time of the last known position. It also includes information on the route and the stops on the various routes.

Cape Cod Regional Transit Authority is planning to install some LED signs and has tested this capability with one sign at the main terminal. When implemented, the signs will provide information on the route number/name, destination, and estimated time of arrival (Real-time Bus Arrival time).

**Types of Media Used (include current and planned)**

Real-time transit information is available to the public only through the Internet Advanced Travel Planner application.

Cape Cod Regional Transit Authority is planning on installing some LED signs that will display next-bus arrival information at the main terminals and the bus shelters.

| Data Collected, Processed and Distributed |
|---|
| The real-time location data are collected from the GPS receiver that is part of the MDT/AVL system. These data along with the mapping database and schedules are used to display the real-time bus location information on the Internet.<br><br>The Moakley Center is working on a prediction algorithm using the AVL data, schedules, historical information for calculating the "next bus arrival information" to display on the LED signs (when installed). |
| **Planning, Operations and Maintenance Issues** |
| Cape Cod Regional Transit Authority is a small-to-medium transit agency whose main goal was to improve their operations by planning and implementing an AVL system. When they started the planning, their original thought was to get an AVL system, then get MDTs and then keep adding more advanced applications as they progressed. They issued an RFP and selected a vendor who was not very familiar with the transit industry but more with the defense industry. So, they dropped this vendor and issued another RFP and the vendor they chose the second time provided them with an integrated solution instead of a building-block solution. The agency went through a big learning curve, and they are finally getting to the point where they are not dependent on the vendor. The system they have now is integrated and also has an open architecture that they can build upon. The real-time Internet application piece was developed by the Moakley Center staff and one of the key members of the staff was also the consultant/project manager for the AVL system.<br><br>The agency realized that there was a lot of data being generated by the system (MDT/AVL) and they had no one within the agency that had enough knowledge to deal with the data and generate specific reports that will help in operations and maintenance of the system. They finally hired a data analyst and this has helped them tremendously. |
| **Architecture and Standards** |
| Cape Cod Regional Transit Authority is part of the SE Massachusetts regional architecture but there is no project-level architecture for this real-time system.<br><br>There are currently no ITS Standards that are being used in the real-time transit information systems. |
| **Business Models, Marketing/Selling** |
| No business models were addressed. |
| **Testing, Customer Satisfaction and Evaluation** |
| The MDT/AVL system was evaluated. |

| Other General Comments |
|---|
| One of the biggest challenges the agency faced was the lack of technical expertise due to the size of the agency. They felt that the system was very complicated for a small transit agency to deal with. Some of the issues they dealt with included:<br>• Vendor and data infrastructure issues<br>• Procurement issues with vendors<br>• Lack of work force and management team to handle the technology within the agency<br>• Training and technological adjustments.<br>One of the solutions that they suggest for smaller agencies is to have a dedicated data analyst or someone with knowledge about the new technology. |

| Transit Agency: | Denver Regional Transportation District (RTD) – Denver, Colorado |
|---|---|
| Real-time Transit Information System | Talk-n-Ride – Phone System<br>Bus Locator – Internet Application<br>Mobile-n-Ride – For Palm and WAP Phones<br>NextBus Demo – For Signs |

**Description of the Real-time Transit Information System**

**Bus Locator**

The Bus Locator real-time information system is an Internet application (www.rtd-denver.com) that provides the ETA for the next two to three bus/rail arrival times based on the route and direction selected. This application was developed in-house and implemented by Denver Regional Transportation District in 1999. The Bus Locator application uses real-time vehicle location data received from the buses through the Denver Regional Transportation District's AVL I System and loop sensor information for the light rail system. The Internet application also shows the current time, and when real-time data are not available, it shows scheduled arrival times.

**Talk-n-Ride (1-888-RTDTRIP)**

The Talk-n-Ride real-time transit information system is an IVR telephone system that provides real-time arrival information for Denver Regional Transportation District buses and light rail and stops and stations. The Denver Regional Transportation District implemented this system in December 2001. A company called VOXEO provides the voice application hosting services. When a user calls 1-888-RTDTRIP, the call is made to VOXEO in California, the user enters basic information on route and direction, and then indicates if they want real-time arrival or scheduled time. The information is then presented for the next two or three buses/rail arrival times. The basic technology used for this system is TTS. Schedules in XML are translated into voice XML. The real-time information is taken from the same server that is used to provide arrival information for the Internet application, which was developed in house, using the AVL data. Denver Regional Transportation District's call volume has been approximately 1,800 calls/month. Denver Regional Transportation District pays a flat rate of 12 cents per minute, and the average time on a call has been 1 minute and 26 seconds. The Denver Regional Transportation District has to pay a minimum of $500/month if there are not enough calls and charges incurred. Apart from hosting the service, VOXEO also provides detailed summary reports on the calls received and information accessed by users. Updated XML schedules are provided to VOXEO through Denver Regional Transportation District's server outside the firewall.

**Mobile-n-Ride**

By using the same data that are presented on the Internet application and the telephone system, the Denver Regional Transportation District implemented Mobile-n-Ride (www.gortd.com), an application to provide real-time next-arrival information to wireless-enabled PDAs and WAP phones. A local company developed this application and provided it to Denver Regional Transportation District. The application is very similar to the Talk-n-Ride application. When the user connects to the Internet web page through one of the specified devices (the application supports more than 440 mobile devices), it takes them through the steps of entering a route number, direction, and stop. When all the parameters are entered, a message appears with the ETA for the next two bus/rail arrival times.

| Description of the Real-time Transit Information System (contd.) |
|---|
| Palm Pilot users can download an application (.pqa) from the Denver Regional Transportation District Web site and synchronize it to their Palm Pilot devices. This, along with wireless access, allows these users to get arrival estimates from the Palm devices that do not support web-based browsing.<br><br>**NextBus Demo**<br><br>The Denver Regional Transportation District is currently participating in a NextBus demonstration to provide real-time bus arrival information at 20 LED signs along three bus routes. Denver Regional Transportation District streams AVL data to NextBus in California where it is analyzed to provide arrival estimates.<br><br>All the real-time applications at the Denver Regional Transportation District are currently using the AVL data from their existing AVL system. The Denver Regional Transportation District has just issued a contract to upgrade the AVL system with new equipment (hardware and software) for approximately $8 million for both bus and rail. |
| **Types of Information Provided (include current and planned)** |
| The real-time transit information provided on the various applications includes the location of the bus/rail line, stops, route name, ETA for the next two bus/rail routes/lines, and current time.<br><br>The Denver Regional Transportation District is one of the main partners of the Transportation Expansion (TREX) project managed by Colorado DOT, which includes several highway and transit improvements in the Denver area. One such improvement is providing real-time parking information status through LED signs leading to the transit park-n-ride lots and other key areas. Information presented will be the status of the parking lot (Open, Closed, Full), not number of spaces. |
| **Types of Media Used (include current and planned)** |
| The Denver Regional Transportation District currently provides real-time transit information to their customers via the Internet, Voice Response System, WAP phones, PDAs, and kiosks.<br><br>The Denver Regional Transportation District also provides real-time transit information through e-mail by sharing their data with a local private traffic company (mytrafficnews.com). Mytrafficnews.com takes the Bus Locator data from Denver Regional Transportation District and sends it to the customers requesting information on transit. Mytrafficnews.com also provides information on traffic and other peripheral requested by their subscribers.<br><br>The Denver Regional Transportation District is participating in the NextBus demonstration (currently in progress) that will provide information on next bus/train arrival on DMS. |
| **Data Collected, Processed and Distributed** |
| GPS-based AVL data from the existing AVL system for buses and the train sensor information for light rail is collected to provide location information. These data along with the scheduling data from the scheduling server (RSA) are processed in-house at the Denver Regional Transportation District to determine the ETA information. These data are available on the server for distribution to the various media. The ETA information generated by the AVL and schedule data are available through the Internet, Talk-n-Ride, and Mobile-n-Ride systems, and to Mytrafficnews.com. |

| Planning, Operations and Maintenance Issues |
|---|
| The Denver Regional Transportation District did not perform any detailed feasibility studies for these applications. The first application deployed was the Internet application, which was developed in house. The rest of the applications were built upon the existing ETA information.<br><br>The accuracy of the ETA predictions has been an issue because of the underlying location data and problems with the equipment. When the data are not accurate or are not being reported from the system, the ETA provided is actually the scheduled arrival time. The Denver Regional Transportation District is hoping that the upgrades to the AVL system will improve the accuracy of the data. |
| **Architecture and Standards** |
| The Denver Regional Transportation District was not aware of their role in any of the regional architectures and the statewide architectures. They are currently investigating it.<br><br>The only standards addressed as part of the contract are Society of Automotive Engineers (SAE) J-1708 for bus and XML for the schedules. |
| **Business Models, Marketing/Selling** |
| No specific business models were addressed. The only private company that uses Denver Regional Transportation District data is MyTrafficnews.com. Denver Regional Transportation District has an agreement with them to use the data. The web site provides customers information on transit, traffic, and other general information via e-mail. |
| **Testing, Customer Satisfaction and Evaluation** |
| Nothing to report. |
| **Other General Comments** |
| One of the issues that the Denver Regional Transportation District is facing is that none of their ITS systems are integrated. The AVL system is being upgraded and a new electronic fare system, new automated annunciators, and new automatic passenger counters (APCs) are being planned. However, Denver Regional Transportation District is finding great difficulty in integrating these separate systems.<br><br>Also, Denver Regional Transportation District would like to enhance the coordination and address some integration issues with CDOT. Denver Regional Transportation District is a major player in the new TREX project, being managed by CDOT, and they hope that this will improve their coordination. |

| Transit Agency: | Fairfax City-University-Energysaver (CUE) Bus System – Fairfax, Virginia |
|---|---|
| **Real-time Transit Information System** | **NextBus** |

**Description of the Real-time Transit Information System**

Fairfax CUE's real-time transit information system utilizes NextBus technology and services. NextBus first approached CUE in 1999 to have CUE as a demonstration site because of its small size and strategic location. CUE did not move ahead with the demonstration because they felt the system was still untested and not market-ready. In February 2001, after the system was perfected and had been implemented in San Francisco, NextBus approached CUE to provide real-time arrival information. Fairfax City Council approved the award of a sole source purchase order in May 2001. The system was launched in early July and was fully operational by August 2001.

Twelve buses running on two routes (Green Line and Gold Line) are equipped with AVL and MDTs, and six DMS are installed at five bus stops and at one Metrorail station (Vienna Station). All signs run on AC power except for one shelter sign utilizing a solar cell.

NextBus location data are received by NextBus in California and all data manipulation is performed there. Projected arrival times are then sent to DMSs at stops and are posted on the web site.

The NextBus contract cost (for the entire system of AVL, signs, software, communications, and installation) was $151,000. There was an additional expenditure of $9,000 for power connection-related construction. Five years of communications and maintenance costs are built into the contract as well as initial training of supervisors.

**Types of Information Provided (include current and planned)**

The current system provides real-time information on arrival times of buses, location of buses, and service delays and/or disruptions; date and time are also provided on both the DMSs and the web site (http://www.nextbus.com/).

DMSs and the web site display arrival times of the next 2 or 3 buses in a "countdown" fashion (e.g. "The Bus Will Arrive in X Minutes"). Vehicle locations, however, are available only on the web site as the DMSs do not have the capability of displaying graphics. By moving the cursor over a particular bus on the map, a small box opens up indicating the name of the next stop and the expected arrival time of that bus. Moving the cursor over a bus stop on the map will cause a small box to open showing the arrival times of the next three buses. Furthermore, My Nextbus allows the user to set alerts so that he/she will automatically be notified by the web browser when his/her vehicle is about to arrive.

CUE also provides visually impaired riders with a device (which they carry with them) that offers them an audio version of the messages on a sign where they happen to be waiting.

| Types of Media Used (include current and planned) |
|---|
| Real-time information is available on DMSs and a web site. The information displayed on the web site can be accessed from personal digital assistants and mobile phones, provided they are wireless application protocol (WAP)-enabled.<br><br>Currently, CUE is not planning on providing real-time transit information through any other medium (i.e., kiosks, IVR systems, fax, or video monitors). |
| **Data Collected, Processed and Distributed** |
| The NextBus system is Internet-based. Internet protocols and communications are utilized throughout the system.<br><br>GPS receivers on the buses provide basic vehicle location (longitude and latitude). CDPD transmits the location information as well as vehicle ID and route number to the NextBus Information Center (NIC). The NIC uses its own database of route/schedule information to develop arrival-time predictions. CDPD is used to transmit the arrival times to the signs at bus stops while the Internet is used to provide the information on the NextBus web site.<br><br>In order to provide accurate arrival time predictions, vehicle location is compared to a database of route-based stop-to-stop segments. Day of the week, time of day, and other historical information is taken into consideration when calculating the arrival time at stops. |
| **Planning, Operations and Maintenance** |
| Because the vendor, NextBus, approached CUE to deploy their system, no feasibility study was conducted nor was a specific set of objectives established. NextBus submitted a proposal to the City of Fairfax that details the functional design of the system.<br><br>Because the system is proprietary, CUE feels that the downside of this approach is it limited expandability and interoperability of the system.<br><br>Some of the operational/maintenance issues that CUE faces include more frequent breakdowns than originally anticipated (about one component every two months); and length of time for the vendor to respond to maintenance issues.<br><br>CUE strongly recommends involving all concerned parties early on in the planning and design of similar projects to avoid unanticipated delays during implementation (e.g., in terms of running power to the shelters). |
| **Architecture and Standards** |
| The regional ITS architecture was still under development when the NextBus system was implemented at CUE. The NextBus system, however, adheres to the City's strategic plan that calls for adopting new technologies. |
| **Business Models, Marketing/Selling** |
| No business model was investigated before implementation of the system.<br><br>The system is marketed via articles in a city-wide newsletter and passenger information brochures on the buses. Also, CUE had an initial dedication event that received press coverage. |

| Testing, Customer Satisfaction and Evaluation |
|---|
| No testing or evaluations have taken place to date. |
| **Other General Comments** |
| The system administrator can produce the following reports from the system:<br><br>Timepoint Adherence Summary by Route; Timepoint Adherence by Vehicle; Timepoint Adherence Summary by Route and Vehicle; Arrivals, Departures and Timepoints for Vehicles, Headway Summary; Headway Summary (Multiple Routes); Headway Detail; Headway Detail (Multiple Routes); Jobs Schedule; Jobs Running; Jobs Missed; Vehicles Reporting; and AVL Report. |
| **Document Requested/Received** |
| We received a copy of NextBus's Proposal to City of Fairfax. |

| | |
|---|---|
| **Transit Agency:** | **Jacksonville Transportation Authority (JTA) – Jacksonville, Florida** |
| **Real-time Transit Information System** | **Passenger Information Display Systems (PIDS) – on the Automated Guideway (SKYWAY)** |

**Description of the Real-time Transit Information System**

The real-time transit information system implemented by the Jacksonville Transportation Authority is part of their commuter rail system, which is an automated guideway system called the Skyway. The skyway system has passenger information displays at each station platform (2 for each platform) that display the next train arrival (countdown). The arrival information is also announced through a PA system at each platform station.

The skyway project was started in 1996 and the deployment phase ended in 2000. The total cost of the system was approximately $182 million. The real-time location is collected from the fixed blocks of the automated train control and this information, along with the schedule data, is processed to calculate the next train arrival information.

**Types of Information Provided (include current and planned)**

The real-time information displayed on the PIDS includes the "next 2 or 3 Train Arrivals in X Minutes," audio announcements, and any delay information (ad hoc message created from the central control and sent to the displays as well as the audio PA system).

**Types of Media Used (include current and planned)**

The real-time information is disseminated through passenger information displays LED signs.

Jacksonville Transportation Authority is looking at buying and installing some kiosks at main terminals.

**Data Collected, Processed and Distributed**

The location of trains is determined through a fixed-block system. Each block has a fixed running time. When a train passes by a certain block, the train information and block code are sent to the automatic train control system central computer. Using this information, the system calculates estimated arrival time. The estimated arrival time is sent to the passenger information displays.

**Planning, Operations and Maintenance Issues**

The passenger information systems were part of the overall Skyway project.

**Architecture and Standards**

This project was not part of any system architecture. It was planned and implemented before the FTA Policy. The Jacksonville Transportation Authority is part of the statewide architecture. Also, there is a plan for the development of an ITS Plan in FY 2003, which is funded by the MPO and the Unified Planning Work Program.

No standards were implemented.

| Business Models, Marketing/Selling |
|---|
| No specific business models were addressed. |
| **Testing, Customer Satisfaction and Evaluation** |
| Nothing was addressed. |
| **Other General Comments** |
| None |

| Transit Agency: | King County Metro – Seattle, Washington |
|---|---|
| Real-time Transit Information System | BusView and MyBus |

| Description of the Real-time Transit Information System |
|---|
| BusView – This real-time transit information system is an Internet application that provides information on the location of the King County Metro buses by tracking them and displaying their real-time location on a map. The real-time vehicle location is collected from the buses through sign posts and odometer readings of the buses. The map is updated every one to three minutes. The new feature in BusView that has been added is an "alarm feature." A user can set an alarm to tell BusView to alert when it is time to leave to catch the bus. The user chooses a specific location (designated points along a route) and sets an alarm. When the bus reaches that point, a message is sent to the user's PC, alerting the user that the bus has reached the requested destination.<br><br>MyBus – This real-time transit information system is also an Internet application that provides detail on the real-time bus arrival of the King County Metro buses. This information is presented in a tabular form that uses the location data that is collected from the sign post and odometer readings. The real-time location data and limited historical data are used in developing an algorithm that predicts the scheduled "real-time arrival." MyBus also provide status information on each bus (e.g., departed, 10 min delay).<br><br>Both applications can be viewed on the main King County Metro web page ((http://transit.metrokc.gov/). Both BusView and MyBus were developed by the University of Washington and King County as part of the SmartTrek Model Deployment Initiative. |
| **Types of Information Provided (include current and planned)** |
| The real-time information provided on BusView includes the location and the time stamp along with the route number and vehicle number. The alarm feature also provides time points (along a route, not necessarily a stop) and distance to the next stop.<br><br>The real-time information provided by MyBus includes route number, destination, scheduled time and departure status (e.g., on-time, delayed "X" minutes", departed). |
| **Types of Media Used (include current and planned)** |
| The real-time information is currently disseminated through the Internet (MyBus and BusView) and through video monitors at some transit centers (MyBus). A demonstration program is available to provide MyBus information on PDAs and WAP phones.<br><br>King County Metro is looking into acquiring and installing some LED DMS signs at bus shelters and Bus Route Transit (BRT) shelters. |
| **Data Collected, Processed and Distributed** |
| Real-time location (AVL) data are collected from the buses based on sign posts and odometer readings. This information, along with the schedules and a geographical information systems (GIS) map database, is processed by the software. The location of the buses is displayed on the BusView application, and a prediction algorithm is used to calculate the real-time arrival information for the MyBus application. |

| Planning, Operations and Maintenance Issues |
|---|
| King County Metro did not originally plan for the real-time transit information system. They planned and implemented the AVL system as part of their operations. University of Washington came to them and presented the capability of developing an application to provide real-time bus location and arrival information using the agency's AVL data. University of Washington had research grants to develop this application and there was no additional cost incurred by the agency to develop this application.<br><br>Since the University of Washington developed the real-time transit application, they have been operating it. King County Metro would like to transition the operation of MyBus and BusView from the University to the agency and are currently working on this transition. The prediction software that was developed by the University for the MyBus and BusView applications is proprietary, so the agency has signed an agreement and is paying a license fee to the University to use this algorithm (renewable every year).<br><br>King County Metro will begin maintaining this system once the transition is complete. |
| **Architecture and Standards** |
| King County Metro is part of the Puget Sound Regional Architecture. Both these projects (MyBus and BusView) do not have a project-level architecture because they were developed before the FTA policy. |
| **Business Models, Marketing/Selling** |
| No business models were addressed. |
| **Testing, Customer Satisfaction and Evaluation** |
| There was an evaluation of the SmartTrek MDI, and MyBus and BusView were included as part of the evaluation report. The report is available on the Electronic Document Library (EDL). |
| **Other General Comments** |
| One of the biggest challenges the agency faced was the accuracy of the AVL data. When they started the AVL project, GPS was not robust enough to consider it a viable solution, so they used the sign post and odometer technology to get location data. Over time, the accuracy of the AVL data has improved due to the hardware and software changes made by the agency.<br><br>The challenge the agency faces now is the transition of operations of MyBus and BusView from the University of Washington to the agency. |

| Transit Agency: | Los Angeles Department of Transportation (LADOT)/Los Angeles Metropolitan Transportation Authority (LAMTA) – Los Angeles, California |
|---|---|
| **Real-time Transit Information System** | **Passenger Information System** |

| Description of the Real-time Transit Information System |
|---|
| The Los Angeles Metropolitan Transportation Authority deployed a new BRT system, called Metro Rapid, to make riding the bus more attractive to the traveling public. The new service uses the city's computerized Automatic Traffic Surveillance and Control System (ATSCS) to move the red-painted Metro Rapid buses through intersections faster. At the same time, Los Angeles Department of Transportation developed a new Passenger Information System that uses wireless electronic displays at its bus shelters to improve information provided to the rider. Currently, real-time information is available on two Metro Rapid lines.<br><br>Every morning, Los Angeles Metropolitan Transportation Authority gives the Los Angeles Department of Transportation command center staff the schedule for each Metro Rapid bus that day. A transponder mounted on the chassis of each bus documents its progress along its route via loop detectors installed at each intersection. Throughout the day an ATSCS computer compares that schedule with the actual location of each bus. If the bus falls behind schedule the computer can extend the green at the traffic signal in its immediate path so that the bus can get back on schedule. Since the computer knows the location and speed of the bus—and the fact that lights in its path will remain green—it can calculate the time the bus will take to reach its next stop. This information is transmitted to a display at bus shelters. The message travels from the ATSAC center to AT&T's nationwide cellular data network, which relays it to a wireless cellular digital packet data/Internet protocol (CDPD/IP) modem built into the electronic display at the target bus stop. Each modem-display unit has its own unique IP address so a series of stop-specific messages can be cascaded along the route to update passengers when a Metro Rapid bus will arrive at their particular location. The one-line panels mounted 9 feet above pavement level display a simple message in 2-inch bright red characters: "NEXT BUS IN 5 MIN."<br><br>The real-time transit information system cost was $600,000. This cost covered the purchase and installation of 44 signs, communications, and software. This does not include the AVL system, which is $3.165 million (equipment at each signalized intersection) plus $100 per bus for the transponders. |
| **Types of Information Provided (include current and planned)** |
| Real-time bus arrival information is available only through the DMSs at Metro Rapid bus stops. Estimated arrival time is displayed as a countdown: "NextBus in X Minutes." The signs are also used to display delay messages whenever a bus is running three minutes late. In this case, the sign will display: "Next Bus Delayed."<br><br>Vehicle location is available at traffic control centers and at MTA's dispatch centers. There have been discussions about putting vehicle location on the Internet, but nothing has been done to date to deploy this.<br><br>The current system is not used to provide information during an emergency/terrorist situation. However, there has been some discussion about displaying Amber alerts (for kidnapped children) on the DMSs. A policy for this service still needs to be formulated. |

| Types of Media Used (include current and planned) |
|---|
| Real-time arrival information is available to the public only through the DMSs at the bus stops.<br><br>The agency is currently looking into expanding the system to the Internet and possibly using WAP mobile telephones and PDAs. They are discussing providing real-time information for rail (both heavy and light rail) as well. |
| **Data Collected, Processed and Distributed** |
| Los Angeles Metropolitan Transportation Authority's real-time transit information system utilizes loop detectors throughout the route to determine bus location. As a Metro Rapid bus passes by one of the loop detectors, bus number, time, date, and loop detector number are transmitted to the central computer using CDPD communications. The central computer looks at the time it took the last bus to traverse the same segment that the approaching bus is about to traverse. The approaching bus is assumed to take that much time to traverse that segment. The central computer will then transmit to the appropriate DMS the anticipated arrival time of the next bus.<br><br>MTA saves the data in an Oracle database, which currently goes back one year. MTA uses these data to fine tune their Metro Rapid bus schedules. Older data are zipped and saved on a CD. Currently, no other agency besides Los Angeles Metropolitan Transportation Authority and Los Angeles Department of Transportation uses the data. |
| **Planning, Operations and Maintenance** |
| The Metro Rapid Program was initiated in March 1999 by the MTA's Board of Directors following an initial feasibility study. The feasibility study recommended that MTA, in partnership with the City of Los Angeles, conduct a demonstration along two to three major arterials that have strong ridership and unique characteristics to provide broad actual experience regarding the feasibility of full-scale deployment of BRT within the MTA system. Phase I demonstration implementation planning was initiated in the summer of 1999, and two lines were selected for the demonstration. The two Metro Rapid lines were implemented on June 24, 2000.<br><br>MTA conducted a feasibility study for the Transit Priority System (TPS), which resulted in TPS providing a faster service and the PIS providing the riders with the perception of high system reliability.<br><br>The team used a systems engineering approach in this project. Through this approach, it was determined that loop detectors were the appropriate vehicle location technology. They also looked at various communications media to communicate data to the signs. They elected to use CDPD. However, two locations along the Metro Rapid had some problems in having their CDPD transmissions picked up. Boosters were installed at City antennas along the route in an effort to overcome this problem.<br><br>One problem that was encountered in the prediction software was the issue of leap-frogging (when a bus goes ahead of another bus running the same route). The PIS algorithm could not handle leap-frogging and was disrupting the prediction time. The algorithm was eventually modified to handle that phenomenon.<br><br>Since the prediction software was developed in-house, Los Angeles Department of Transportation noted that more guidance on how to improve arrival prediction time would have been greatly helpful. All specifications were developed and project management was conducted in-house by Los Angeles Department of Transportation. |

| Architecture and Standards |
|---|
| The project has a project-level architecture and complies with the National ITS Architecture, particularly related to the Advanced Traffic Management System (ATMS) aspect. |
| **Business Models, Marketing/Selling** |
| Although no formal business model was followed, the agency was interested in providing a better overall transit service with higher reliability and faster running times. The following were the objectives defined for the project:<br>• Provide as much accurate information to the public as possible<br>• Reduce riders' anxiety<br>• Monitor and track bus performance<br>• Improve schedule adherence<br>• Provide remote system management.<br><br>The system is marketed through advertisements in MTA's publications. |
| **Testing, Customer Satisfaction and Evaluation** |
| Testing was performed during implementation of the system. No testing or evaluation of customer satisfaction was conducted after the completion of the system. |
| **Other General Comments** |
| None |
| **Document Requested/Received** |
| None |

| Transit Agency: | Metra Commuter Rail – Chicago, Illinois |
|---|---|
| Real-time Transit Information System | TrainTrac™ Train Information Monitoring System (TIMS) |
| Description of the Real-time Transit Information System/s | |

The real-time transit information system at Metra, the commuter rail division of the Chicago Regional Transportation Authority (RTA) was primarily implemented to allow the agency operational staff to track their trains and collect information on delays and disruptions on their lines. The main goals of the project were:

- To monitor location and performance-to-schedule of all commuter trains operating on Metra, BNSF and Union Pacific
- To provide automated station and emergency announcements on board and automated reminders for customers needing special assistance
- The ability to number trains, revise schedules, generate and send announcements from a central location to any train
- To evaluate operation in real-time when making decisions during service changes or service disruptions.

The TIMS system was developed in two phases by the system integrator, GeoFocus®. Metra conducted a pilot for 2 years on a small segment (8 cars) and then implemented the system for the entire fleet by December 2001. The total cost for the system was $4.3 million. Each train is equipped with a GPS receiver, which allows the train to continuously determine its location. Utilizing a CSX wayside 900 MHz radio system and transmission towers along the corridor, a transponder on the train transmits the train location to the TIMS server located at Metra's GPS Center. The trains also are equipped with a Mobile Information Terminal (MIT), which the conductor uses to enter a text message on delays. This text message is sent via radio to Metra's GPS center. Once transmitted to the GPS center, location data and delay information are received and processed by the TrainTrac™ TIMS Server software. The messaging software provides detailed information on the train location, arrival time, departure time, and delay (minutes late), along with a visual display of the train as it moves. The same software is used to send the automated next-stop announcements to the trains through the on-board annunciation. Metra personnel also use this automated system to send messages on delays, emergencies or any other courtesy information (courtesy announcements are available from a pre-defined pull-down list).

The TrainTrac™ console information is shared through Metra's local area network/wide area network to various Metra departments, including passenger services, safety, administration, maintenance, and operations.

| Types of Information Provided (include current and planned) |
| --- |
| The system currently provides “next stop” audio announcement through on-board annunciators. Metra personnel have the ability also to send real-time delay information emergency/safety information, and courtesy information automatically from the GPS center to the trains through the on-board annunciators.<br><br>Metra plans to provide the same information through LED signs on the platform and through audio announcements in the platform as the next phase of the project. |
| **Types of Media Used (include current and planned)** |
| Next-stop announcements are made through the on-board annunciators and the only real-time information provided through these is the delay information and emergency/safety information.<br><br>Metra is planning to implement wireless visual (through LEDs) and audio messaging at stations. The agency also is planning to provide delay and service disruptions information through Internet service alerts and subscription pager alerts. |
| **Data Collected, Processed and Distributed** |
| The data collected from the trains include location from the GPS and information entered by the driver into the Mobile Information Terminal (MIT).<br><br>The location data and the MIT data are sent to the Geofocus Train Information Server and processed by the on-train messaging software to track the trains and provide automated announcements.<br><br>Information that is currently disseminated to the public includes automated next stop announcements through on-board annunciators. Occasionally delay information, emergency and evacuation information, and courtesy information also is announced through the on-board annunciators. |
| **Planning, Operations and Maintenance Issues** |
| There was no feasibility study performed for this project, but as discussed earlier, Metra conducted a pilot on a small fleet before implementing the system for the entire fleet.<br><br>When Metra decided to implement the system for the entire fleet, it had an extremely ambitious time frame and due to problems with installation and other constraints, the implementation took them much longer than they had planned. Metra plans to have a realistic time frame for future upgrades to the system. |
| **Architecture and Standards** |
| This project is part of the North Eastern Illinois Regional ITS Architecture. Metra is one of the service boards of Chicago Regional Transportation Authority, and it is working with them to integrate future projects into their Regional ITS Plan and the regional system architecture.<br><br>No standards were implemented. |
| **Business Models, Marketing/Selling** |
| No specific business models were addressed. |

| Testing, Customer Satisfaction and Evaluation |
|---|
| Nothing addressed |
| **Other General Comments** |
| Metra recommends that any transit agency that plans to implement real-time transit information systems should first investigate the availability of wireless communications. Metra suggests that the agency hire a consultant to investigate the available local wireless providers and their monthly charges during the planning stages of the project. |

| | |
|---|---|
| **Transit Agency:** | **Northeast Illinois Regional Transit Authority (RTA) – Chicago, Illinois** |
| **Real-time Transit Information System** | **Active Transit Station Signs (ATSS) - Pilot** |

**Description of the Real-time Transit Information System**

The Chicago Regional Transportation Authority is currently implementing a real-time transit information system pilot program called Active Transit Station Signs (ATSS) that will display "next train arrival" information at four Chicago Transit Authority rail stations (Chicago Transit Authority is one of the Chicago Regional Transportation Authority's service boards). At the time of the interview, one of the stations was equipped with a sign and the rest of the three were in the installation progress. The system integrator for the program is INOVA Corporation and the total cost of the project is approximately $3 million (includes electronic signs at the O'Hare and Midway Airport Baggage Claim areas that were added to the contract later).

The information displayed on the station signs will include next train arrival as a countdown display. This information is calculated by using the schedules and location data from the existing Chicago Transit Authority (CTA) Train Monitoring System. The CTA operates a train monitoring system that collects location data from the track circuits and these data along with the schedule adherence value and the time tables are used to calculate the "next train arrival in X minutes" value.

The Chicago RTA would like to extend this system to all 142 CTA stations if the pilot is successful.

**Types of Information Provided (include current and planned)**

The current pilot program will provide real-time information on the "next train arrival in X minutes" in a countdown fashion, along with the route, date, and time. Real-time information on service disruption (e.g., delay, incidents) also will be displayed on the ATSS. A customer assistant at each station will be given a touch-screen console to display pre-defined messages. The CTA controller at the control station also has the option to create an ad hoc message that can be displayed on the sign.

The Chicago RTA also plans to provide highway information on travel times and incidents. This is planned mainly at the airports. Chicago RTA wants to provide information on travel time to pre-defined locations using highway and CTA, giving the travelers an option and an incentive o choose transit. They plan to get this information by interfacing to the Gateway Hub, which is part of the GCM (Gary-Chicago-Milwaukee) system.

**Types of Media Used (include current and planned)**

The pilot project will include dissemination of the real-time information through DMS-type LED signs.

The Chicago RTA also plans to provide real-time information through an Internet application, a 511 system (which is being planned for the whole region), WAP phones and PDAs, and kiosks at major terminals.

| Data Collected, Processed and Distributed |
|---|
| The train location data are collected from existing CTA track circuits and sent to the train-monitoring system. The ATSS control server interfaces with the CTA train monitoring system to collect the location, CTA timetables, and the schedule-adherence value to calculate the next train arrival information. The processed data are stored at the CTA control center and there is a plan to have a redundant interface to these data to the Chicago RTA Transit Hub (Planned).<br><br>The next train arrival information (countdown) is sent from the control center to the signs using wireline communications and displayed on the signs. Any other information obtained from the gateway system on specific highway information (e.g., incidents also will be displayed. |
| **Planning, Operations and Maintenance Issues** |
| The Chicago RTA performed a feasibility study for this project in December 1998 and their main objective for this pilot was to demonstrate a system that can provide reliable next train and next bus arrival information. It was included as part of the RTIP (Regional ITS Plan) and they developed the functional requirements in house and used a consultant to write the detailed specifications. They reviewed the specifications with an ADA subcommittee and also with the CTA Mobility Advisory Committee.<br><br>They are currently in the process of installing the signs. The Chicago RTA signed an intergovernmental agreement with Chicago Transit Authority that details roles, responsibilities, and maintenance of the signs. |
| **Architecture and Standards** |
| The ATSS program is part of the Chicago RTA's RTIP (Regional ITS Plan), which includes a system architecture. This pilot program is also addressed in the North Eastern Illinois Regional ITS Architecture.<br><br>In the RFP, they initially specified the use of NTCIP standards but realized that 1203 (DMS standards) were not suitable for the ATSS signs. The standards did not have all the capabilities they wanted (i.e. graphics, bells and whistles). |
| **Business Models, Marketing/Selling** |
| No business models addressed. |
| **Testing, Customer Satisfaction and Evaluation** |
| There is a planned evaluation of the Pilot ATSS system. |
| **Other General Comments** |
| None |

| Transit Agency: | River Valley Transit – Williamsport, Pennsylvania |
|---|---|
| Real-time Transit Information System | Transit Information System |

**Description of the Real-time Transit Information System**

River Valley Transit (formerly CityBus) operates fixed-route service using 28 buses on 13 routes. In addition, paratransit service is provided with one directly operated vehicle as well as supplementary service from other providers (e.g., taxis) on an as-required basis.

River Valley Transit had a systems integrator recently develop a TIS that focused on customer information needs at the downtown transfer center (the Trade and Transit Center).

Bus bays at the transfer center are located along city streets around a one-block area. Incoming buses must select whichever bus bay is available at the time, making it a challenge for customers to find their bus. The TIS uses two variable text message signs to display the bay number for each bus as well as to warn when a bus is about to depart. Each of these variable signs has 10 rows of two-inch height characters. Each row is labeled for one of the 10 different bus bays, and indicates the route name for any bus currently occupying that bay. There is also a public address system that provides audible announcements for the sign messages.

Each bus is equipped with an MDT, which the driver uses to send a message to the dispatch center indicating the selected bus bay. The TIS uses this message to automatically update the signs. The driver also sends a text message about 20 seconds before departing, and this alert is indicated on the signs. The mobile data communications uses spread-spectrum antennas; bus antennas use unlicensed radio frequency spectrum to communicate with transfer center antennas over a limited range on a "line of sight" basis.

The system relies on the driver selecting the correct bus bay number for their original text message (i.e., the TIS does not automatically monitor the locations of buses or where they have stopped). An error-checking routine generates a text message back to the driver if the system indicates a bus already occupies the selected bay number. There is a system display for customer service staff at the transfer center, allowing the sign and driver messages to be monitored.

This system went into operation in January 2000, with the overall process from planning through implementation taking about 1-½ years. The overall system capital cost was about $200,000. The most significant recurring cost that can be distinctly associated with the TIS is the $8,150 annual maintenance fee to the systems integrator. One additional cost is $30/month for a telephone line that supports communications with a duplicate monitoring screen display at the administrative headquarters.

River Valley Transit has issued an RFP in 2003 for expanding the TIS to provide an Automatic Vehicle Location/Computer Aided Dispatch (AVL/CAD) system throughout the service area. The RFP also will invite proposals for:

- On-board diagnostics monitoring
- IVR telephone system and web site application enhancements
- Upgrading two non-interactive kiosks in the transfer center, which currently only provide general information about the downtown area, to provide interactive access to transit information using a touch-screen interface

- Implementing a similar interactive transit information kiosk at a shopping center, as there are plans to enhance the role of this location as a remote transfer center.

The current MDTs are equipped with GPS receivers, but it is expected that the MDTs will be replaced with Mobile Data Computers (MDCs) that can also control additional on-board equipment. Two buses are already equipped with MDCs prototypes, including integrated on-board next stop announcements.

Before AVL/CAD can be installed, the existing wide-area mobile data communications system needs to be upgraded to add a dedicated radio channel for mobile data communications. There was an attempt to use the current single radio frequency to send vehicle GPS location reports to the TIS from the current MDTs, but it was discovered that the required voice communications did not leave sufficient capacity on the channel for frequent data messages from each vehicle. Once the enhanced system is in place, it will be determined whether the GPS locations will allow an MDC to reliably generate an automatic arrival message when the bus enters a pre-defined "triggerbox" area at the bus bay.

**Types of Information Provided (include current and planned)**

The system currently provides general service information with their web site and customer service agents, and transfer information (at the downtown transfer center using the TIS). A variety of additional types of information are envisioned as possible elements of an upcoming expansion of the TIS, depending on the responses they receive on their current RFP. These include estimated stop arrival times, vehicle location, service delays information, customer general information messages, and weather information.

**Types of Media Used (include current and planned)**

Current media for traveler information are limited to their web site, telephone calls to customer service agents, the transfer center variable message signs, and the downtown non-interactive kiosks.

Planned media include an IVR telephone system, interactive kiosks, and video monitors.

**Data Collection, Processing and Distribution**

The system information, about the messages that were displayed on the signs and exchanged with drivers, is retained in the system for 180 days. There are also daily hard copy reports, and after the 180 days has expired these reports are the only information that is retained.

**Planning, Operations and Maintenance**

There was no formal feasibility study for the original TIS implementation, or for the current enhancement plans. The origin was the specific set of limited objectives for using technology to assist customers with finding their buses in the new transfer center. Based on these objectives, the overall consulting team for the transfer center developed a brief functional specification and included it in the invitation for bids on the general electrical contract. There was little opportunity for River Valley Transit to consult with other agencies about how to most effectively use technology for their requirements, as they believe they were one of the first agencies to attempt such an application.

The electrical contract was awarded to the lowest bidder and the TIS system was thus awarded to the integrator that the electrical contractor had selected for inclusion in its bid. In hindsight, River Valley Transit realizes that it was lucky to have acquired an effective integrator and technology solution through this low-bid approach. If the integrator in the original low electrical bid had later proven a poor choice, River Valley Transit would have likely lost time in needing to release their TIS functional requirements again using an RFP process.

The original number of spread spectrum antennas proved insufficient to communicate with the many different locations of buses around the transfer center (this short-range communications method requires a substantially clear line of sight), but this was addressed by adding additional antennas at various locations.

To date, the approach to maintenance has been to have an annual maintenance agreement in place with the vendor. Under this agreement, the vendor is to implement for River Valley Transit any software upgrades it develops to this product for other clients. The vendor also completes a quarterly inspection of the system and its equipment. River Valley Transit has a spare MDT and wireless modem and has been trained for swapping out a failed unit (to be shipped to the vendor for repair or replacement).

The primary organizational issue was with drivers, since the system relies on them using the MDTs consistently and correctly. This was addressed through training, meeting with the drivers to explain the purpose of the system, and using the same route codes as drivers were already using for their electronic headsigns.

**Architecture and Standards**

There has been no formal ITS Strategic Planning effort. This project is not part of any regional architecture development process and does not incorporate any ITS standards.

**Testing, Customer Satisfaction and Evaluation**

Although River Valley Transit had only limited objectives for the initial TIS implementation, they feel they are getting fewer complaints from customers than they would have expected if the system had not been developed (i.e., complaints about customers having trouble finding their buses). However, there has been no formal evaluation.

**Document Requested/Received**

A copy of the current RFP for enhancing the TIS was requested.

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|---|---|
| **Transit Agency:** | **San Luis Obispo Transit (SLO Transit) –<br>San Luis Obispo, California** |
| **Real-time Transit Information System** | **Efficient Development of Advanced Public Transportation Systems (EDAPTS)** |

**Description of the Real-time Transit Information System**

In 2001, San Luis Obispo Transit completed the installation of EDAPTS prototype ITS equipment on their buses and at bus stops to test the operational suitability of ITS technology in a small transit agency environment. The EDAPTS concept, and the prototype equipment, were developed and designed by Cal Poly researchers and undergraduate engineering students under a research contract funded by Caltrans Division of New Technology and Research NTR and the FTA. EDAPTS is designed for small and rural public transportation agencies and focuses on basic functionality, expandability, and affordability matched to their smaller budgets. EDAPTS was developed with special attention given to providing low, post-deployment operating and maintenance costs.

The project consisted of providing a computer-aided dispatching (CAD) software and equipping 18 vehicles with GPS receivers and MDTs, and equipping bus stops with DMS. Signs display number of minutes until bus arrival. The signs are solar powered, controlled by wireless links.

The system total cost was $266,000. This included $170,000 for bus equipment (GPS receivers, MDTs, farebox ID card readers, and radios), $76,000 for eight solar powered signs (including their installation), and $20,000 for dispatch workstations and software. Monthly communications cost is $17 per bus for voice and data, and only $35 for all sign communications.

This project is a cooperative research effort involving the California Department of Transportation's Division of New Technology and Research (Caltrans NTR), California Polytechnic State University at San Luis Obispo (Cal Poly), the FTA, and San Luis Obispo Transit.

**Types of Information Provided (include current and planned)**

The current system provides real-time information on arrival times of buses, location of buses, and service delays and/or disruptions.

DMSs display arrival times of the next bus in a countdown fashion (e.g. "Route 34 Here in X Minutes"). Vehicle locations, however, are available only on the dispatchers' monitors as the DMSs do not have the capability to display graphics. The dispatchers' monitors identify the last stop that a particular bus was at and its schedule adherence.

Although San Luis Obispo Transit has not provided any general information (e.g. fares, routes etc.) on their signs, they nevertheless have the capability to do that. The city is interested in providing real-time parking information (i.e. number of parking spaces available at parking facilities and departure time of the next bus) but they have not planned for such a system yet.

| Types of Media Used (include current and planned) |
|---|
| Currently, information is provided only through DMSs at the bus stops in addition to dispatchers' monitors. The agency is currently developing the mechanism to provide arrival time and bus locations on the Internet. As of October 2002, this effort is 95% complete.<br><br>The electronic signs are in compliance with Americans with Disabilities Act (ADA) as they have three-inch letters. However, there are no audio announcements available.<br><br>The system does not utilize any interactive kiosks at the meantime. Nevertheless, the agency has thought of adding kiosks to EDAPTS. |
| **Data Collected, Processed and Distributed** |
| Rather than move the information over specialized data links, the EDAPTS team chose to "piggy-back" the digital data on the standard analog voice radio system that is used by San Luis Obispo Transit to communicate with the drivers. This is possible in a smaller system because there is typically unused radio channel capacity, where short data transmissions can fill the "gap" between voice transmissions without interfering with normal voice communications traffic.<br><br>Another innovative technique being used at San Luis Obispo Transit is to lower the operational cost of communicating with the DMS units deployed at the bus stops. These units have a built-in intelligence module that allows all deployed signs to listen to a single, bundled text message sent by way of a pager. This one message contains the updated data for all signs at all stops. Each Smart Transit Sign is easily programmed to know the bus stop(s) and bus route(s) it is servicing. Once the text message is received, the "smart" sign strips out and uses only the information meant for its specific location. It then uses this information to inform the waiting passengers of the time remaining until the bus arrives at that specific bus stop. This technique allows the transit agency to limit its Smart Transit Sign communication link costs. |
| **Planning, Operations and Maintenance** |
| The Cal Poly team worked with the local public transit agencies to determine their basic ITS needs. They did this by performing a "needs analysis". Upon completion, the process showed that the most needed ITS capabilities in the San Luis Obispo area were: an AVL system, silent alarm/emergency feature, real-time arrival information, CAD system, and an enhanced fare collection system.<br><br>One problem encountered during implementation was the speed of communications. Initially, dial-up was used. This technique was pretty slow for its intended use, taking up to 3 minutes. Switching to pager interface communications reduced transmission time to 20-40 seconds.<br><br>During the first few weeks of deployment, drivers had an issue with the on-board MDTs. Drivers were being distracted when driving (drivers were constantly looking at the MDTs). With time, however, drivers were no longer getting distracted by the MDTs and had a positive reaction to the MDTs.<br><br>In terms of maintenance, San Luis Obispo Transit feels that they should have identified, early on in the planning process, which department should be responsible for maintaining the data stored at the DMSs in order to avoid delays in getting the data updated. |

| Architecture and Standards |
|---|
| Although EDAPTS was implemented before the development of Caltrans District 5 Deployment Plan, it nevertheless meshes well with the Plan.<br><br>EDAPTS is consistent and compliant with both the National ITS Architecture and Transit Communications Interface Profiles (TCIP) Standards. EDAPTS is open-source and non-proprietary. |
| **Business Models, Marketing/Selling** |
| No business model was investigated as this was more of a research project to figure out a low-cost way of providing real-time transit information.<br><br>The project's objectives were to provide better, more reliable passenger information; develop a system that is accessible to small to medium size transit agencies; and develop a system that can be deployed in incremental phases.<br><br>San Luis Obispo Transit is currently seeking private sector partners for this system. They are interested in the private sector to add value from the logistical aspects of EDAPTS. |
| **Testing, Customer Satisfaction and Evaluation** |
| Generally, drivers have a positive reaction to real-time schedule adherence information, given the complexity of the new schedules which vary hour by hour.<br><br>In November 2001, CAL Poly conducted a customer satisfaction survey. The on-board survey covered a small-sample of 148 riders, of which 120 were frequent riders. The researchers found that 77% of the riders surveyed reported that they had obtained information about their buses from one of the EDAPTS signs. About 28% reported that the real-time information they received from the signs helped them make a transfer. In general, 89% of the riders surveyed indicated that the new real-time information system enhances San Luis Obispo Transit service. |
| **Other General Comments** |
| |
| **Document Requested/Received** |
| EDAPTS – Efficient Development of Advanced Public Transportation Systems, paper presented at the 2002 Application of Advanced Technologies in Transportation Conference |
| Copy of the onboard survey |

| Transit Agency: | San Francisco Municipal Railway – San Francisco, California |
|---|---|
| Real-time Transit Information System | NextBus System – Buses and Light Rail |

**Description of the Real-time Transit Information System**

The real-time transit information system implemented by San Francisco Municipal Railway started as a demonstration project by a private provider, NextBus. They demonstrated the capability to provide real-time next train arrival information using the location data from San Francisco Municipal Railway light rail vehicles (LRVs) in 1996 on LED signs installed at train station platforms for the 22 Filmore Lines. The demonstration turned into a pilot in 1999 and San Francisco Municipal Railway implemented NextBus for the whole light rail fleet by March 2000. The NextBus system includes signs on the station platform that provide next train arrival information for the next 2 or 3 trains. San Francisco Municipal Railway has recently issued a Notice to Proceed on a new contract to NextBus to outfit all their revenue and some non-revenue vehicles with an AVL system and passenger information displays at bus shelters and more train stations. The contract was signed recently (as of October 2002) and is worth $14 million (includes outfitting all revenue vehicles and 60 non-revenue vehicles, providing other equipment, and up to 400 signs (without electrification), and wireless charges for 3 years). The new system will replace, enhance and expand, a Motorola sign-post system (existing AVL system for some of the buses), the NextBus system pilot program (for light rail vehicles), and a pilot cable car AVL system by @Road.

The NextBus information, for real-time San Francisco Municipal Railway rail arrival information is also available on the Internet (www.nextbus.com). The Internet application provides a map with the option to select one rail line or all lines and displays the lines and stops. When you select or move your cursor to any stop along the rail route, information on the stop, the route and the next three train arrivals (in minutes) are presented. The Internet application also provides "web alerts" called "MyNextBus" that allows the user to set alerts so that he/she will automatically be notified by the web browser when his/her vehicle is about to arrive. The NextBus system also provides the same information through wireless enabled PDAs, WAP phones and selected two-way messaging units.

The NextBus system (pilot currently implemented) uses the location data (currently from rail), interfaces with the Automatic Train Control (ATC) System to get vehicle location while the vehicle is in the subway, and uses a proprietary algorithm to calculate the estimated time of arrival for the next two or three trains. This information is then displayed to the passenger information signs using CDPD to the Internet and to other wireless devices.

In order to provide accurate arrival time predictions, vehicle location is compared to a database of route-based stop-to-stop segments. Day of the week, time of day, and other historical information is taken into consideration when calculating the arrival time at stops.

**Types of Information Provided (include current and planned)**

The current pilot system provides real-time information on the location of the trains, the route, date and time (on the signs). Information on delays, and other peripheral information on safety alerts, sports, school information, etc. is also provided on the signs. There is an option to create an ad hoc message at any time either by the ATC or by the NextBus system. There is one video monitor at the Embarcadero station that displays the location of the trains (this is mainly used for operations).

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| The same types of information are planned for San Francisco Municipal Railway buses through the new contract. Audio announcements are required via Talking Signs technology in the new $14 million contract. |
| **Types of Media Used (include current and planned)** |
| Real-time information is available on DMS using LED for light rail (16 characters wide) and via the web site (www.nextbus.com). The information is also accessible through WAP Phones, PDAs, and some two-way pagers.<br><br>As part of the new contract, San Francisco Municipal Railway plans to acquire and install 15 kiosks at high volume train stops and terminals. |
| **Data Collected, Processed and Distributed** |
| GPS-based AVL data for light rail vehicles operation on the surface and location data from the ATC system for light rail vehicles operating in the subway along with schedule data from the existing scheduling system are collected and sent to the NextBus Information Center (NIC). The NextBus system interfaces with San Francisco Municipal Railway's ATC to get current and updated schedules. These data are then processed by NextBus using their proprietary software to calculate "next arrival information" and then distributed to the users and the agency through various channels. The processed data are stored in the NextBus database and also sent to the agency database. The next two or three train arrivals are displayed on the signs along with the route/line. The current date and time is also displayed on the signs. The same information is presented on the Internet web page.<br><br>In the new contract, San Francisco Municipal Railway included a clause that states that San Francisco Municipal Railway "owns" the data. If NextBus plans to use these data, add value to it, and resell it in any other way, they will have to get San Francisco Municipal Railway's approval. |
| **Planning, Operations and Maintenance Issues** |
| San Francisco Municipal Railway did not perform any feasibility studies or plans because the project started with NextBus conducting a demonstration of their capabilities using San Francisco Municipal Railway's data for no cost to MUNI. During the demonstration, San Francisco Municipal Railway only paid for the wireless charges. The demo then turned into a pilot and ran for three years successfully. The main objectives for the new contract to outfit the whole system with NextBus are to improve and expand this passenger information system and to generate an archived vehicle location database for schedule adherence and performance monitoring and reporting.<br><br>During the pilot test, San Francisco Municipal Railway had a couple of issues, such as who was going to assume responsibility for putting the hardware on the new vehicles. Also when buses were out of service and the location was not being relayed, San Francisco Municipal Railway was still paying wireless charges for those buses. The other issue is the cost of communications. They currently use CDPD because it is off-the-shelf technology but it is very expensive especially when there are a large number of signs. San Francisco Municipal Railway is looking into ways to migrate from CDPD to another communication technology. |

| Architecture and Standards |
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| San Francisco Municipal Railway is part of the Metropolitan Transportation Commission's Regional ITS System Architecture that is under development. The NextBus system will be included as part of the architecture that is being developed.<br><br>The only standards addressed as part of the contract are Society of Automotive Engineers (SAE) J1708 for buses and IEEE 1473L for LRVs. |
| **Business Models, Marketing/Selling** |
| No specific business models were used for this system. However, NextBus has their own model in which they use agency operational data (i.e. location data), install all equipment (both in-vehicle, at central dispatch and bus/train stops) and operate the signs. |
| **Testing, Customer Satisfaction and Evaluation** |
| The new contract has testing and evaluation phases. |
| **Other General Comments** |
| One of the main concerns that San Francisco Municipal Railway has is the proprietary nature of this system. It is not clear how San Francisco Municipal Railway intends to manage this system in the long run. San Francisco Municipal Railway has addressed the issue of data rights and has retained the ownership of the data. But the main processing and dissemination of the next train/bus arrival information is provided by a proprietary system.<br><br>The other issue that San Francisco Municipal Railway is dealing with is how to roll out this type of technology for the whole fleet with limited funding. Their initial funding will support the first year. |

| Transit Agency: | Tri-County Commuter Rail – Pompano Beach, Florida |
|---|---|
| Real-time Transit Information System | "Train Tracking" |

**Description of the Real-time Transit Information System**

Tri-Rail had become very interested in being able to provide customers waiting at stations with real-time delay information due to the double-tracking initiative. So, a local firm, GeoFocus®, implemented the TrainTrac™ Train Information Management System (TIMS) in 1995-1996. Each train is equipped with a GPS receiver, which allows the train to continuously determine its location. Utilizing a CSX wayside 900 MHz radio system and transmission towers along the corridor, a transponder on the train transmits the train location to the CSC.

Once transmitted to the Tri-Rail CSC, data are received and processed by the TrainTrac™ TIMS Server software. Customer service agents, management and Herzog operations (the agency that operates and maintains Tri-Rail trains) are each equipped with the TrainTrac™ Console client software that displays real-time train location and status. Although CSX railroad operations are also equipped with TrainTrac Console, they rarely use it, as the software does not distinguish between CSX and Amtrak trains.

Each station platform is equipped with at least two red LED DMSs as well as a public address system with speakers. Signs face either up or down the platform, with two lines of 2-inch high text characters. The DMSs at each station communicate over a leased line with a System Messaging Server at the CSC. The system cost was $900,000. This cost included all required software to run the system, transponders, GPS receivers, and a one-year maintenance contract.

**Types of Information Provided (include current and planned)**

The current system provides real-time information on arrival times of trains, location of trains, and service delays and/or disruptions. The date and time are also provided on both the LED DMSs and the Internet (http://www.tri-rail.com).

LED DMSs and the Internet display arrival times of the next train in a countdown fashion (e.g. "Train in X Minutes"). Train locations, however, are available only on the Internet as the LED DMSs do not have the capability to display graphics.

Messages at train stations are also provided in audio format to accommodate visually impaired passengers. Audio messages are automatically played whenever text messages are updated.

Delay information is provided on the signs via an ad hoc message. Since an ad-hoc message usually takes several minutes to send over the 56 kilobits per second SynchroNet service, this capability is not used frequently. When it is used, an audio version of the ad hoc message is not sent.

| Types of Media Used (include current and planned) |
|---|
| Real-time arrivals of trains are available through the LED DMSs at the stations and the Internet. The Internet site also displays the location of the trains. However, Tri-Rail is planning on utilizing other media for the dissemination of train arrival times. Tri-Rail is planning to provide interactive kiosks at stations that would display real-time arrival information, time, weather, and other relevant information. Also, Tri-Rail is planning on capitalizing on new technologies by providing real-time information to personal digital assistants and web-enabled cell phones. |
| **Data Collected, Processed and Distributed** |
| Each train is equipped with a GPS receiver, which allows the train to continuously determine its location. CSX uses a 900 MHz radio system for its signaling system, which a transponder on the train uses to transmit the current train location. This information is received at CSX dispatch in Jacksonville, Florida. From there, it is forwarded to the Tri-Rail CSC in Hialeah, Florida using a leased line. A mobile information terminal is connected to the GPS receiver/radio unit in each active train that the conductor uses to enter a text message detailing the reason for any delay. This text message is sent via radio to the Tri-Rail CSC. Once transmitted to the Tri-Rail CSC, location data and delay information are received and processed by the TrainTrac™ TIMS Server software. Real-time train location and status information are made available to Customer service agents, management, CSX dispatch and Herzog operations.<br><br>The signs at each station communicate over a leased line with a System Messaging Server (SMS) at the CSC. SMS software is networked with the TIMS Server software, which automatically triggers the messaging server to activate various platform messages. The messaging server only needs to send a message number, since the scripts (for the various messages that can be triggered automatically) are stored in an Electronically Erasable Programmable Read Only Memory (EEPROM) chip within each sign. This stored data defines the text to be displayed on the sign as well as the audio message to be played over the public address speakers.<br><br>Each visual and audio announcement is provided in both English and Spanish. It is also possible to record an ad hoc message on the messaging server and send the entire message to selected platform signs for an immediate announcement. However, receiving the large transmission takes several minutes over the 56 kilobits per second SynchroNet service; hence, Tri-Rail rarely resorts to this method and uses it only when there is an urgent need for it. |
| **Planning, Operations and Maintenance** |
| When the double-tracking work was first being planned, Tri-Rail was concerned about the varying train delays it would cause and the impact these disruptions might have on its ridership. And when GeoFocus® approached Tri-Rail to deploy their system, this system seemed to provide the answer to Tri-Rail as they were mainly interested in being able to know where the trains are at any given time. In order to deploy the system in the shortest possible time, Tri-Rail used an expedited procurement mechanism that limited the up-front planning time in exchange for quicker "start-up." In retrospect, Tri-Rail would like to have had more time to explore other vendors and other products to determine the system that would best meets its needs.<br><br>Tri-Rail's biggest issue with the current system is that there is more manual effort required than originally thought. Even information presented on the web site is not automatically displayed on a currently opened window unless the user manually refreshes the screen. Another issue is that the speed of data transmission (over the 56 kilobits per second SynchroNet Service) makes sending ad hoc messages very inefficient and hinders efforts to provide audio ad hoc announcements. |

| |
|---|
| When it comes to maintenance, Tri-Rail believes that a more structured approach to dealing with equipment and software failures is needed. This is because there usually is a great deal of finger pointing among the companies that provide support (communications company, DMS company, etc.) |
| **Architecture and Standards** |
| The region does not have a regional ITS architecture. The existing system does not have a project-level architecture. |
| **Business Models, Marketing/Selling** |
| No business model was investigated before implementation of the system. The system is marketed via articles in various brochures and publications on the web, and through 1-800-TRI-RAIL. |
| **Testing, Customer Satisfaction and Evaluation** |
| No evaluations have taken place to date. |
| **Other General Comments** |
| |
| **Document Requested/Received** |
| |

| Transit Agency: | Tri-County Metropolitan Transportation District of Oregon (Tri-Met) – Portland, Oregon |
|---|---|
| Real-time Transit Information System | Transit Tracker |

**Description of the Real-time Transit Information System**

Portland Tri-Met's Transit Tracker real-time transit information system (next bus and train arrival) is presented to users through two types of media, the Internet and LED signs at light rail stations and some bus shelters. The Internet application (www.tri-met.org) currently provides information for nearly all Tri-Met's bus stops (more than 8000 bus stops). The MAX (light rail) train arrival information is scheduled to be added soon. The Internet application allows the user to choose a route, the direction and a specific bus stop and then provides the user with the estimated time to the next two bus arrival/s in a countdown fashion. The user has the option to view more arrivals for different bus routes and stops.

Tri-Met also has installed several LED signs at MAX stations and at bus shelters. They are in the process of installing more signs. They are scheduled to install an additional 50 by the end of the fiscal year 2003 and plan to eventually install a total of 250. The LED signs on the MAX station platforms currently display "next scheduled arrival time" and not the countdown to the "next train arrival." Tri-Met is currently working on some issues on the frequency of the train location information and the algorithm for the early/late value on the train side. On the bus shelters, the LED signs display the "next bus arrival" as a countdown. In one downtown location (transit mall area) where there is more than one bus and more than one route served, there is a multi-line LED display, which shows the route number, direction, and estimated time of arrival for the next three or four buses.

The location data collected from the buses and trains are sent to the dispatch center. The buses use GPS receivers that are part of the AVL system; the trains use the loop sensors buried in the track to determine vehicle location. These location data are used along with schedule data to determine the time the vehicle is "early or late." The system then broadcasts an early/late message to all the signs identifying the message by the block numbers. The signs have an internal memory unit, which has all the schedules stored by block number. When the signs receive the early/late message, the unit compares that value to the scheduled value and then rounds it off to the closest minute and provides a "countdown" for the estimated next bus/train arrival. The Internet application was developed in house, but it uses the same data (early/late) and provides the next bus arrival information on the web page.

**Types of Information Provided (include current and planned)**

Real-time information provided by Tri-Met on the Internet and the LED signs include "next bus/train arrival (departure for end of the rail line) as a countdown. The LED signs also provide current date and time.

Tri-Met plans to add an audio component to some of their signs to announce the next bus/train arrival (at key locations).

| Types of Media Used (include current and planned) |
|---|
| Tri-Met currently provides real-time transit information through the Internet and through DMS using LED at MAX station platforms and bus shelters.<br><br>Tri-Met plans to purchase and install kiosks at major terminals and airports along with providing their customers the capability of accessing their real-time transit information on the web site through WAP phones and PDAs. They also plan to provide information through video monitors for areas where there is a need for multi-line displays (e.g., transit malls). |
| **Data Collected, Processed and Distributed** |
| Train location data from existing loop sensors and bus location data from GPS-based AVL system are polled and collected at the dispatch center. The location data along with schedule and time are used by the Transit Tracker application to calculate the schedule adherence and this value is broadcast to all the signs and the Internet application. The early/late value is then compared to the scheduled value (in the sign) to calculate and display the "next arrival time" as a countdown. The processed data are stored at the agency's dispatching and information systems server. In the future, these data will be shared by the regional transportation status server that is under development by the Oregon Department of Transportation (ODOT) to foster data sharing on all modes of transportation in the region. |
| **Planning, Operations and Maintenance Issues** |
| Tri-Met started planning and modeling the Transit Tracker system after they visited and learned more about the London Countdown system. They decided to use the London system as an example and build upon their current AVL system to provide real-time information. They investigated several approaches including the NextBus business model. They did not choose NextBus because they wanted to own and operate the system internally rather than pay for the service. So they finally chose to negotiate with their AVL vendor, to develop the early/late algorithm.<br><br>Tri-Met has 11 bus and 29 rail signs installed (as of September 2002). One of the big issues they had and continue to have is about installation. They have had problems getting power to the sites with LED signs and this situation has had an impact on their schedule.<br><br>The other issue they need to address is the cost of communications. Currently they use cellular digital packet data (CDPD) because it is an off-the-shelf technology but it is very expensive. Tri-Met is investigating other communication options as they install more signs. |
| **Architecture and Standards** |
| Tri-Met is included in the ODOT Region 1 System Architecture. This project has been described in Tri-Met's 5-year ITS Plan.<br><br>They are currently not using any ITS Standards except for J1708 for bus. |
| **Business Models, Marketing/Selling** |
| No business models were addressed. |

| Testing, Customer Satisfaction and Evaluation |
|---|
| A federally funded evaluation was conducted and a status report has been published. There is a follow-up evaluation scheduled for next year.<br><br>There have been three surveys that were conducted by Tri-Met. The first one was in the Spring 2000, which was a pre-test before the installation of the signs. The second one was in January 2001, which was an immediate response survey after the installation of the 1st sign. The last survey was the intercept survey, which was conducted one week after the installation of Transit Tracker at 10 bus locations and 11 rail locations.<br><br>Transit Tracker on the web is currently being evaluated. |
| **Other General Comments** |
| A copy of the Transit Tracker evaluation report was provided. |

| Transit Agency: | Virginia Railway Express (VRE) – Alexandria, Virginia |
|---|---|
| **Real-time Transit Information System** | **Train Brain and Train Talk** |

**Description of the Real-time Transit Information System**

Virginia Railway Express is a commuter rail service operated along two lines (Manassas and Fredericksburg) from Virginia suburbs to downtown Washington, DC. In DC, both Union Station (the terminus) and L'Enfant Plaza Station are served. The outer termini are in Fredericksburg (in Spotsylvania County) and in Manassas (at Broad Run Airport in Prince William County). There are 18 stations along the two lines.

Virginia Railway Express offers two real-time transit information innovations – Train Brain and Train Talk. These are unrelated projects although both convey information about current train delays to the riders over the Internet, the first through a web site, the second via e-mail. Train Talk has been around about four years while Train Brain was implemented about one and a half years ago. These systems were implemented in house.

**Train Brain:** Train Brain is a schedule-based java applet program that displays the location of Virginia Railway Express trains on a map on the Virginia Railway Express web site (www.vre.org/trainbrain/disrupt.shtml). Initial planning began in late 1999 when Virginia Railway Express was interested in acquiring this system from a vendor. They negotiated a low price ($5,000) since the vendor was interested in a site he could use to demonstrate the program. The program was procured through a sole source purchase order. The system was implemented in about seven months. Virginia Railway Express pays an annual license fee of $3,000-$4,000 as well as fees for maintenance hours at a fixed rate per hour as needed.

Train Brain integrates the pre-existing GPS and Train Information Provider (TRIP) systems so it can update the location of trains as shown on the web site. The Train Brain web page on the Virginia Railway Express web site displays the trains operating according to schedule. The display is periodically updated with information about delays from the Communications Center that derives from the GPS system or from the train conductor. The system is not fully automated as Train Brain only shows delays that customer service decides to show. The customer service agent must verify the delay before a delay message is prepared. The customer service agent then clicks an ok box and the e-mail is generated that creates the Train Brain applet. Location of the train on the map is updated accordingly.

**Train Talk:** Train Talk provides e-mails about Virginia Railway Express train status to riders that sign up for this service. There are 6,500 passengers on the Train Talk e-mail list, which is a relatively high number given that the daily ridership is 12,000-14,000 one-way. Train Talk is not route- or station-specific; that is, the same e-mails are sent to all Train Talk customers.

Although Train Talk e-mails can be received by cell phone, the system was not set up for small devices and does not work well with PDAs. Virginia Railway Express is currently experimenting with sending train-specific information to cell phones and PDAs. Three hundred riders are currently experimenting with this.

| Types of Information Provided (include current and planned) |
|---|
| Train Brain provides location of each train on a system map displayed on the web site. The first header on the Train Brain web site also has information about major problems and delays; this information is directly derived from Train Talk. (The already-prepared Train Talk information is cut and pasted onto the web site using DreamWeaver software.)<br><br>Train Talk e-mail messages inform the participating users of any delays or problems. Train Talk is also utilized to disseminate information that is educational or explanatory in nature, such as information about the new fare collection system or any speed restrictions that are in effect. |
| **Types of Media Used (include current and planned)** |
| Train Brain utilizes the Internet to display location of trains as well as to display any delay or service disruption messages.<br><br>Train Talk e-mail messages are sent to participating users; currently some users are receiving these on PDAs and cell phones as part of a pilot project.<br><br>Delay information is also provided through a 1-800 IVR telephone information system. More detailed announcements are voice recorded and are disseminated via the IVR system. This system has a hierarchy of information. For example, if a train is 10 minutes late or more, the phone line would state "there is a delay on the ___ line"; to get more specific information, the caller can select the line or train number and listen to the more detailed message. The IVR system also has the capability to fax the delay information to the rider upon request. |
| **Data Collected, Processed and Distributed** |
| Although both Train Brain and Train Talk utilize GPS technology to determine location of trains, these information systems are not entirely automated. The customer service agent makes the decision whether to report the delay of a particular train based on a certain threshold (typically 10 minutes or more).<br><br>Data sent from the train to the main computer are sent through CDPD communications.<br><br>Train Brain and applet reside on a Virginia Railway Express server and are run from that server. Data received are stored in an SQL database. |
| **Planning, Operations and Maintenance** |
| The Internet applet at first was not compatible with older browsers being used by some customers and/or other agencies. They resolved this by modifying the software to be compatible with at least the past 2 or 3 versions.<br><br>Currently, Virginia Railway Express has some problems in getting communications from trains in some locations. Virginia Railway Express has been looking into using a different communications system in order to have better than 90 percent coverage. |
| **Architecture and Standards** |
| Virginia Railway Express does not have an ITS plan yet and no ITS standards were used. |

| Business Models, Marketing/Selling |
|---|
| No business model was investigated before implementing Train Brain. However, they were interested in providing the riders with more and better information on their train travel.<br><br>Virginia Railway Express already has a policy on sharing data. The policy does not allow for modifications to the data, requiring that whatever information is published/displayed must match the information posted on Virginia Railway Express's web site. This is simply to prevent the rider from getting confused by contradicting information. |
| **Testing, Customer Satisfaction and Evaluation** |
| In 2001, Virginia Railway Express conducted a passenger survey. The survey included two questions related to Train Talk but Train Brain was not addressed in the survey. About 79 percent of the riders rated timeliness of Train Talk as either "Very Good" or "Excellent" while only 4 percent rated the service as below average. Also, 84 percent of the riders rated Quality of Train Talk as "Very Good" or "Excellent" while only 5 percent rated it as below average. |
| **Other General Comments** |
| None |
| **Document Requested/Received** |
| Virginia Railway Express Passenger Survey 2001 (results) |
| Virginia Railway Express Passenger Survey 2001 (questionnaire) |

| | |
|---|---|
| **Transit Agency:** | **Washington Metropolitan Area Transit Authority (WMATA) – Washington, DC** |
| **Real-time Transit Information System** | **Passenger Information Display System (PIDS)** |

**Description of the Real-time Transit Information System**

In an effort to provide better service to its customers, Washington Metropolitan Area Transit Authority planned on introducing a real-time PIDS that would provide elevator/escalator outages, incident information, and actual arrival times of trains. An RFP was released in 1995, and a vendor was selected to deliver the system. The system consists of 430 DMSs—both indoor and outdoor. The entire system cost was almost $12 million although the original bid was for $5 million. In April, 1999, installation of the system began and by 2001, the system was operational.

Using a fixed-block system, the Rail Operations Computer System (ROCS), which is not a part of the PIDS system, determines the location of the train and computes its projected arrival time. ROCS conveys this information for each fixed-block. The PIDS system software looks at the next 2 trains of each direction and destination less than 20 minutes away. The arrival times of the next two trains are then displayed on the DMSs.

There are two inputs to the LightLink server that manages the sign displays –PIDS and Other Clients. PIDS is the real-time (actually time-critical; there is a short latency) component. The location of the train is determined based on position by the fixed-block system. One message is generated per block. This information establishes the fixed time that it takes to get to the next station hence, estimated arrival time. The Other Clients provide messages from Passenger Operations and Marketing that could be about an emergency, an incident, an event, or just background information. Elevator/escalator availability information is still done manually though they do hope to automate.

**Types of Information Provided (include current and planned)**

DMSs at Metrorail stations display arrival times of the Metro trains in a countdown fashion, “Red Line/6 Cars/4 Minutes.” The DMSs are also used to provide information during an emergency or terrorist situation. Time is also displayed on the DMSs.

A Board decision was made banning the use of the DMSs for advertisements.

The agency uses the DMSs to disseminate events messages especially on weekends when there is more time between trains and therefore greater opportunity for other messages to be displayed.

**Types of Media Used (include current and planned)**

Currently, DMSs are the only medium used for displaying arrival time information. WMATA is not planning to use any other medium for arrival time information at this point. It is, however, developing a capability for the customer to get e-mail or pager alerts on delays on specific lines and elevator outages on a subscription basis.

The WMATA web site also displays any major delay or service disruptions.

| Data Collected, Processed and Distributed |
|---|
| Location of trains is determined through a fixed-block system. Each block has a fixed running time. When a train passes by a certain block, the train information and block code are sent to the ROCS central computer. Using this information, the system calculates estimated arrival time. The estimated arrival time along with line (color)/ destination and number of cars are sent to a group of signs at a particular station. A multiplexer then directs the message to the right sign. The arrival time is displayed on the signs for a specific time. To remove the message from the DMS, the computer has to communicate with that particular sign and directs it to remove the message. Not only does this delay the system and affect its efficiency, but also could be an expensive alternative as it doubles the communications usage.<br><br>WMATA is considering improving on this by embedding the "removal" time in the message itself. The sign would then remove the message once the preset time expires, which should reduce communications traffic considerably.<br><br>WMATA does not share PIDS data although they share some other data with the police. They currently have no official policy on sharing data. However, any request for data is considered at the Secretary's office.<br><br>WMATA believes that there is a capability for the customer to get alerts on delays on particular lines and/or elevator outages via e-mail or pager. A prototype has been developed for this service.<br><br>WMATA has a separate program that an IT staff designed in June 2002 to allow WMATA to check the status of the system (not of the trains). It tells which signs are down, disconnected, or reconnected. This is used for monitoring purposes and for failure analysis and is available on the agency intranet. It shows a 30-day bar chart of incidence of down signs by sign. The status information is archived in an Oracle database.<br><br>WMATA is planning to update its train location system into a schedule-based system. |
| **Planning, Operations and Maintenance** |
| The original purpose of the PIDS was primarily to identify elevator/escalator problems at Metro stations and display—using DMSs—which elevator/escalator is down. Later in the planning process, arrival time of trains was added.<br><br>Staff developed a set of objectives and providing train arrival information to the user was a subsequent objective. The project started in the summer of 1999 in the Operations Branch of WMATA with input from the Rail Transportation Department.<br><br>Although several engineers from a few departments were involved in the design and specifications of the system, Washington Metropolitan Area Transit Authority's Information Technology staff indicated that there should have been broader involvement earlier in the process and now procedures are in place to be more inclusive in the planning and design of such systems.<br><br>The system was procured through an RFP process, and a software/hardware vendor was selected for this turnkey project.<br><br>Initially, there were problems with communications with signs. The vendor thought it was a modem that was causing the problem. It turned out that there was a problem with the software developed by the vendor. |

Another problem with the software is that it was taking about two minutes to get information to be display signs. After the software was modified, it now takes only few seconds to get the data to the signs.

The current system does not provide announcements in audio format. The signs do have speakers but they are not used for audio communication of PIDS information. These speakers are currently tied into the existing Public Announcement (PA) system although the system specifications did not address any such integration or coordination.

At first, signs at stations used to show next train arrival information even when another train is waiting at the station. This used to confuse riders as they thought that the train waiting at the station is indeed the same as the train displayed on the DMSs. As a result, many riders ended up getting on the wrong train. The software was modified to resolve this problem. Now, when a train is waiting at the station, no information on future trains is displayed.

**Architecture and Standards**

No ITS standards were in place at time of design and implementation. However, Transmission Control Protocol/Internet Protocol (TCP/IP) standards were used. The system was designed as a fully integrated system and there is a project-level architecture.

**Business Models, Marketing/Selling**

No business process engineering was done to determine business goals and customer expectations, design the user interface, and estimate the staff requirements and role.

WMATA staff interviewed strongly believe that a business plan and full buy-in from the organization is a must for any project, especially such big projects. For example, stakeholders should have to sign-off on a service-level agreement showing what they expect and documenting up-front their responsibilities/roles as well as setting up a mechanism for problem resolution.

WMATA staff did not understand the complexity of installing signs in an operating system; staff stated that they would have benefited from a procedures guide for the installation process including identification of the need for escorts.

WMATA's Information Technology (IT) group became involved in the PIDS when that office took over the computer group that was responsible for the rail operating system, which was about 2½ years ago, just about the time of installation and this was about 5 years into the project. As a result, they ended up spending too much time fixing problems with the system—communications, software, and interfacing. In retrospect, the IT group indicated that they should have been the project manager from the start or at least been involved as a major partner. There seems to be more awareness today of getting all stakeholders involved from the very beginning of the project.

**Testing, Customer Satisfaction and Evaluation**

Acceptance testing was conducted with consultant support. The system is now fully accepted.

WMATA conducted a field test with 8 testers; in the course of this test, they asked customers about the PIDS and got many compliments. Follow-up in-process with the Public Affairs office may yield additional information on customer response.

The agency hopes to expand passenger information displays to bus customers and may conduct a complete review/redesign of the PIDS system on Metrorail in the future.

| Other General Comments |
| --- |
| Washington Metropolitan Area Transit Authority is currently investigating how much information a person can absorb (in terms of number of messages displayed as well as number of words per message). |
| **Document Requested/Received** |
| None |

| Transit Agency: | Washington State Ferries – Seattle, Washington |
|---|---|
| Real-time Transit Information System | Vessel Watch |

**Description of the Real-time Transit Information System**

The real-time transit information provided by the Washington State Ferries is an Internet application (http://www.wsdot.wa.gov/ferries/) that provides information on the location of their vessels by tracking them and displaying their real-time location on a map. The location information is collected from the vessels through a GPS receiver, which was installed 10 years ago as part of the Coast Guard Operations. The vessels are represented as colored arrows on the map (directional) when they are moving and as colored circles when they are stopped. The vessel locations are shown based on the route selected from a drop-down menu. The route names are also represented on the map alongside the moving arrows. The vessel watch information is updated every 3 minutes. The Internet application was developed in-house with help from contractors from Washington State DOT.

The agency also provides information through e-mail alerts to their subscribers that can be personalized based on the route selected. These alerts are not in real-time and are currently sent 24 hours prior if there is a vessel that is down and not on the schedule. They currently have over 9000 subscribers.

**Types of Information Provided (include current and planned)**

The real-time information provided by Washington State Ferries includes the location of the vessels, the current date and time and the route (with destinations).

Washington State Ferries would like to provide real-time delay information on the Internet web page or through other media.

**Types of Media Used (include current and planned)**

The real-time information is available on the Internet web page. Information on delays is available to e-mail subscribers (not yet in real-time though) through WAP phones.

Washington State Ferries is investigating ways to allow customers to download their schedules to their WAP Phones and PDAs and also to receive real-time delays. They would also like to provide real-time information through video monitors installed at the ferry terminals.

| Data Collected, Processed and Distributed |
|---|
| The location information from the vessels (collected from the GPS receivers) is relayed to the Washington State Ferries through a private provider. The provider owns the infrastructure (towers and the frequency) and relays the information from the vessel to Washington State Ferries' dispatching center as part of the Fleet Track system (CAD/AVL). This system was also developed for Washington State Ferries to track, manage, and operate their vessels. The Fleet track application also provides the ferries with detail on each vessel, which is used to generate reports for analysis, schedule adherence, and other operational issues. The Washington State Ferries pays a flat rate/hour/vessel to use the communications infrastructure. The provider also archives the AVL data for the agency.<br><br>The location information along with the schedule information and a map database is used to provide information on the web page on the vessels. |
| **Planning, Operations and Maintenance Issues** |
| The Washington State Ferries wanted to implement a system to track their vessels. When they implemented the Fleet Track system, they felt that they could share this information with their customers. So, with a couple on-call contractors, they developed an Internet application that would display the real-time location of their ferries.<br><br>They selected an Internet application because they wanted the capability to turn off the system anytime they had any major operations issues. |
| **Architecture and Standards** |
| They are part of WSDOT but there is very little coordination between them. They are not aware of being a part of any system architecture.<br><br>There are no ITS standards being used. |
| **Business Models, Marketing/Selling** |
| No business models were addressed. |
| **Testing, Customer Satisfaction and Evaluation** |
| None addressed |
| **Other General Comments** |
| The Washington State Ferries would like to provide their customers with real-time information on delays on their vessels and also try and provide it using other media like LED signs. But unfortunately their funding is limited. They are looking at innovative ways of trying to work with the private industry to share the costs. One such example is the ferrycams. Washington State Ferries owns and operates some of the cameras and provides shots of them on the Internet. But there are some locations that did not have any cameras, so some of the private companies and organizations that wanted to advertise came up with the idea of installing and maintaining the cameras at some locations and Washington State Ferries provided them with the space and the approval to place them. This agreement has worked well and the links to the cameras are available on the Washington State Ferries web page. |