ITS Applications for Coordinating and Improving Human Services Transportation

A Cross-Cutting Study



Improving Service for the Transportation Disadvantaged

August 2006

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Foreword

Dear Reader,

We have scanned the country to bring together the collective wisdom and expertise of transportation professionals implementing Intelligent Transportation Systems (ITS) projects across the United States. This information will prove helpful as you set out to plan, design, and deploy ITS in your communities.

This document is one in a series of products designed to help you provide ITS solutions that meet your local and regional transportation needs. We have developed a variety of formats to communicate with people at various levels within your organization and among your community stakeholders:

- Benefits Brochures let experienced community leaders explain in their own words how specific ITS technologies have benefited their areas.
- Cross-Cutting Studies examine various ITS approaches that can be used to meet your community's goals.
- Case Studies provide in-depth coverage of specific approaches being taken in communities across the United States.
- Implementation Guides serve as "how to" manuals to assist your project staff in the technical details of implementing ITS.

ITS has matured to the point that you are not alone as you move toward deployment. We have gained experience and are committed to providing our state and local partners with the knowledge they need to lead their communities into the future.

The inside back cover contains details on the documents in this series, as well as sources to obtain additional information. We hope you find these documents useful tools for making important transportation investment decisions.

Sincerely,





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Executive Summary

Older adults, persons with disabilities, and individuals with lower incomes frequently do not have access to transportation or their access to transportation is limited. These populations, called "transportation disadvantaged," need flexible yet dependable routes and schedules, easily understood traveler information, low-cost fares that are easy to understand, and transportation that is safe and secure.

This report highlights technologies that improve accessibility for the transportation disadvantaged. A special emphasis is placed on those technologies that improve coordination of agencies, services, functions, or modes because coordination can result in greater efficiency and service delivery improvements.

One of the greatest challenges to implementing technologies is that of coordinating the goals and functions of multiple agencies. Obstacles to coordination include different rules and standards among the various agencies, different funding streams, and limited guidance. A technology solution that enables coordination among different agencies can lead to long-term organizational efficiencies not possible with a manual system for coordination.

It must be noted that only technologies that have been deployed will be emphasized in this report. Updated information on technologies and applications is available at the Intelligent Transportation Systems Joint Program Office website (http://www.its.dot.gov) and the United We Ride website (http://www.unitedweride.gov).

This report profiles six diverse sites that have successfully deployed ITS technologies to improve transportation options for the transportation disadvantaged. While these agencies have used different approaches, based on their needs and in-house capabilities, all have emphasized the importance of coordination and flexibility in providing service.

Based on their experiences, these agencies have many lessons to share.

- **Technologies should be phased in incrementally, ironing out the problems with each technology before adding another layer of complexity.**
- **Training of staff, operators, drivers, and users is crucial to allay apprehensions and ensure complete and accurate use of the system.**
- **Regular meetings between system providers, subcontractors, policy makers, special interest groups, and agency managers allow stakeholders to share problems and ideas and to build consensus.**
- **ITS technologies produce a massive amount of data, and a commitment to data quality is essential.** There is usually more than one use for a data set. Mining and reusing the data can lead to insights which form the basis for operational improvements.

- **It is important to be a "smart client" for vendor-supplied software. It is particularly important to assess the vendor's longevity and integration capability, avoid excessive modifications of the software's functionality, and insist on on-site training and support.**

With the high degree of variability among transportation providers and the areas they serve, there is no single technology or configuration that will be appropriate for all areas. Fortunately, with the breadth of technologies that are currently available and the degree to which technology can be customized, an ITS application can generally be developed for almost any setting.

The deployment of ITS technology will inevitably require overcoming some hurdles, either technical or institutional. By examining what others have learned, many valuable insights can be gained and many challenges overcome. This report, which documents solutions from agencies that have already implemented ITS technologies, can help other agencies make these transportation service improvements a reality.

Introduction

Large numbers of transportation-disadvantaged people are without access to a private vehicle. Their concerns include: how to find alternative transportation, how to pay for it, and if it is safe.

Who Are the Transportation Disadvantaged?

For older adults who have had to curtail or completely cease driving, for persons with physical or cognitive disabilities, and for people who are unable to afford a vehicle, transportation needs are fundamental. For these people, obtaining access to any form of convenient, dependable, and affordable transportation can be a challenge. Although there are 62 different Federal programs to provide assistance, being able to find the right program and to coordinate the program with available transportation options is daunting at best.[1]

What Are Their Transportation Needs?

These populations have well-defined needs: access to easily understood traveler information, low fares that are simple to understand and pay, safety and security, access to transportation with sufficient service coverage, convenient schedules, and reasonable journey times. Transportation issues include physical, sensory, and cognitive limitations, income constraints, and concerns about personal wellbeing. Addressing these issues and needs usually requires coordination of services among multiple agencies, carriers, and modes.

It is true that sometimes these needs are well satisfied by small agencies, using nothing more than phone, fax, pegboard, and determination. In agencies across the U.S., however, demand for transportation services is growing, and the need for technology to help meet the demand is becoming obvious.

What Are the Challenges to Meeting These Needs?

Coordinating services among multiple transportation providers is a significant challenge because these organizations often have different goals for, approaches to, and capabilities of meeting the needs of transportation-disadvantaged communities. Four agencies fund most of the transportation services of the transportation-disadvantaged populations: the Department of Transportation (DOT), Department of Labor (DOL), Health and Human Services (HHS), and Department of Education (DOE). For each of the transportation-disadvantaged populations, programs may be administered by more than a single agency. For example, Temporary Assistance for Needy Families (TANF) is administered through HHS and Job Access Reverse Commute (JARC) is administered through DOT. While the programs are different, they both serve low-income populations.

[1] General Accounting Office (June 2003). *Transportation-Disadvantaged Populations*. GAO-03-697. http://www.gao.gov/new.items/d03697.pdf.

When a city or agency makes plans to deploy ITS technologies, policy issues can be as important to consider as the technology itself. Reaching a consensus among different agencies or organizations, or across political boundaries, is not simple. Obstacles include differing standards and policies among the various agencies, varying funding streams, and limited guidance. Figure 1 displays the complexity of these relationships and the difficulties of communication.

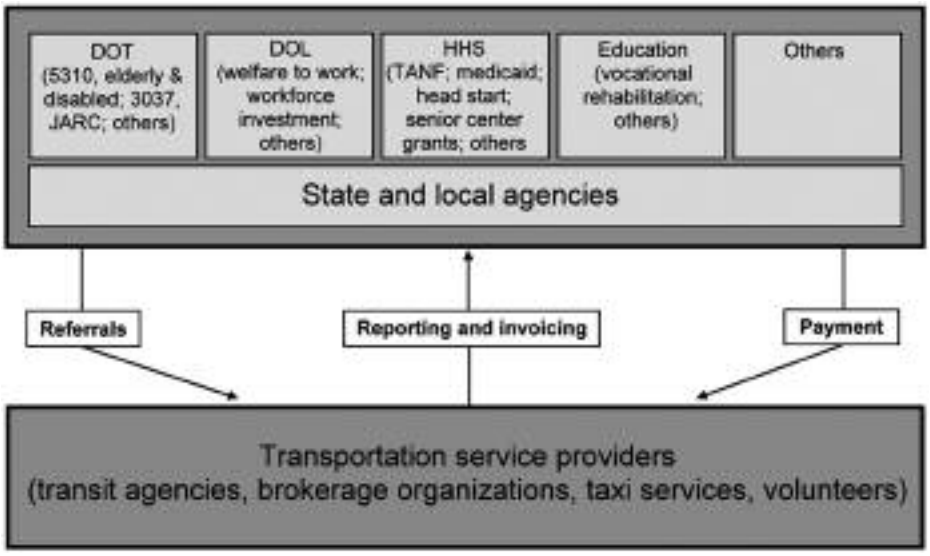


Figure 1 - Examples of Federal Funding Agencies and Programs That Assist States and Local Agencies with Human Services Transportation

Paratransit is often more expensive than fixed-route transit. In addition, the number of paratransit trips is growing. Use of ITS technologies to increase flexibility, efficiency, and coordination may be an effective way to reduce costs.

Rapid changes in technologies are another challenge. It is difficult to decide on the right time to implement a new technology because of the fear that tomorrow may bring a better technology.

Another issue is the tremendous challenge of meeting a wide variety of needs within these populations. Even in the community of people with disabilities, the needs of a person with a sensory loss (e.g., sight, hearing) are different from the needs of a person in a wheelchair or a person with a cognitive disability.

How Can ITS Technology Help?

ITS technologies involve computers, electronics, and communications systems for improving the surface transportation system. A primary goal of the U.S. DOT and the transportation industry is to use ITS to move people more efficiently and with greater safety. In the following sections of this report, specific examples from six focus sites (Figure 2) illustrate how these agencies used ITS technologies to provide an effective means for improving transportation operations, safety, and customer satisfaction.



Figure 2 - Locations of the Six Focus Sites Highlighted in This Report

ITS Technologies that Improve Human Services Transportation

Transportation service providers employ ITS to provide traveler information, lower costs, decrease travel times, and provide more convenient routes and schedules. Such technologies include location software and equipment (automatic vehicle location [AVL] and geographic information systems [GIS]), computer-aided dispatch (CAD), mobile data terminals (MDTs) or mobile data computers (MDCs), and coordination and integration software. Integration software may be used to coordinate fare payment and billing operations, passenger counting, vehicle location, or other functional and operational requirements.

Example costs for several of the ITS technologies described in this report are available. For more information on system costs, please see the *Intelligent Transportation Systems Benefits, Costs and Lessons Learned: 2005 Update*[2] and the ITS Benefits and Costs website http://www.benefitcost.its.dot.gov.

Technologies that are of greatest benefit to transportation-disadvantaged populations and have proven track records for improving efficiency are shown in Table 1. The table is categorized by technologies that are used directly by the individual and those that are used directly by organizations that operate the transportation system. Organization-related technologies, although less directly visible to the transit user, impact the user through improved transportation operations, convenience, safety, and security.

While certain transit designs (e.g., kneeling buses or buses with innovative scooter securements) are important for transportation-disadvantaged populations or the transit agency, they are not part of the ITS technology family and will be mentioned only briefly in this report.

Transportation Operations and Coordination

One of the most visible benefits of improved transportation operations and coordination is increased flexibility for the transit rider in scheduling and taking trips. Flexibility provides riders options for scheduling appointments, such as medical, personal, and reverse commutes. With the right data, agencies can determine which routes need vehicles with specific design characteristics, such as wheelchair loading and restraint systems, and can provide flexibility in the schedules for these routes. For low-income travelers, flexibility is needed also for accessing crucial stops such as childcare locations and shopping centers. Near 24-hour-a-day service may be critical for reverse commutes, as well as convenient multimodal connections without lengthy waits.

[2] U.S. DOT (2005). *Intelligent Transportation Systems Benefits, Costs, and Lessons Learned: 2005 Update*. http://www.itsdocs.fhwa.dot.gov/jpodocs/repts_te/14073.htm, EDL# 14073.

Technology	Purpose
Passenger-related technologies	
Traveler information • Internet websites • Automated telephone systems • Audible enunciators • Kiosks • Transit stops with automated information	Advanced traveler information systems (ATIS) provide the customer (i.e., transit passenger) with traveler information electronically. The information may be static or real-time. The content might include schedules, fares, routes, transfers, arrival time of next vehicle, and/or availability of special accommodation equipment. Information can be provided on the transit vehicle, at the transit stop, available through the Internet or over the telephone. Automated travel itinerary planners are included in this category.
Electronic fare payment	This technology allows the rider or human services agency to pay for transportation services on one or more transit systems electronically using a smart card or magnetic stripe card. While the passenger sees only the card, the operational component uses the data to simplify billing and payment.
Surveillance and security systems	Safety and security technologies include video surveillance cameras, silent alarms and covert microphones on vehicles, and “smart” cards for driver identification. Surveillance and security systems can be provided in transit vehicles and at transit stops and stations.
Organization-related technologies	
Automatic Vehicle Location	Using a positioning system, such as the global positioning systems (GPS), and a GIS, the operating agency can track its buses. Combining AVL with ATIS, the agency can alert riders with real-time information; combining AVL with CAD, the agency can reroute vehicles to provide flexible service.
Computer-Aided Dispatch	CAD is used to assist agencies in dispatching paratransit vehicles and is typically integrated with AVL and other information management technologies, such as scheduling and routing software.
Mobile Data Terminals/Mobile Data Computers	An MDT/MDC is a small on-board computer and interface that links the driver to an agency’s computer network through wireless communications.
Coordination and integration software	This technology helps agencies with scheduling, routing, billing, and reporting. Typical applications include coordinating paratransit routes and schedules within a single agency or among multiple agencies, coordinating fare card usage and billing among multiple agencies, and integrating software systems across multimodal transit systems.

Table 1 - ITS Technologies That Benefit Transportation-Disadvantaged Populations

Another key benefit to improved operations and coordination is reliability. Reliable transportation benefits older clients and clients with disabilities who do not want to wait for long periods of time, nor do they want to miss medical appointments. Reliability also is important for low-income populations to meet job commitments.

Coordination of functions and services among agencies and within a single agency is critical to ensure flexibility. Coordination of services might involve fixed-route transit, paratransit providers, and non-transit options. This coordination could include one-stop shopping for multimodal options. The benefit to users is that they only need to understand one system and make arrangements (e.g., reservations, payment) with a single agency.

Traveler Information

Among transit agencies, traveler information systems are one of the most commonly deployed ITS technologies that directly benefit passengers. These technologies provide trip and general services information to travelers. Information may be static or real-time and may be tailored to suit a particular traveler's needs. Depending on the application, information can be provided using the Internet, telephone, fax machine, and electronic signs or audio enunciators at kiosks, at transit stops, or in vehicles. Information provided over the Internet can be accessed by personal computers, personal digital assistants (PDAs), Web-enabled cell phones, and electronic kiosks. Information provided over the telephone can be automated using interactive voice response (IVR) or voice recognition systems. Information may also be disseminated using telecommunications Device for the Deaf/Teletype (TDD/TTY) equipment.

Accessible and easily understood traveler information can include operating hours, service area and routes, schedules, fares, location of the nearest transit stop, transfer options, accessibility information and availability of transportation-assistive devices such as wheelchair lifts, and the estimated arrival time of the next transit vehicle. Automated annunciation systems on transit vehicles visually display and audibly announce the vehicle route and destination and the location of the next stop.

Other technologies include automated trip planners and trip reservation, cancellation, and confirmation systems. Trip planners produce trip itineraries based on travelers' inputs and needs, such as accessible stops, stations, and vehicles. Trip reservation, cancellation, and confirmation systems allow customers to book, confirm, or cancel trips with a transportation provider using an IVR telephone system and/or the Internet. When integrated with an AVL system, the reservation, cancellation, and confirmation system can notify customers automatically, by phone or e-mail for example, when to expect the arrival of a vehicle.

Fare Payment and Billing

Technology can help lower the cost of fares and can make fare payment simpler. Electronic fare cards reduce operating costs by centralizing and automating records. In addition, the passenger does not need to have exact change or even know the fare. In this way, electronic fare cards can help to reduce bus boarding times.

There are two basic types of electronic fare cards—magnetic stripe cards and smart cards. Magnetic stripe cards have a magnetic stripe that contains read-write data, such as the value on the card. Magnetic stripe cards, which typically cost less than smart cards, have been in use for over 25 years. There are two types of magnetic stripe card systems—those in which one swipes the card through the reader and those in which one inserts the card into and then removes it from the reader. The read-write units of the card insertion/removal type of magnetic stripe card system experience failure more often than the swipe type of system.

Smart cards are plastic cards with an integrated circuit that contains information readable by specific devices. There are basically three types of smart cards:

- Contact cards, the older smart card technology, require the card to come in contact with the card reader.
- Proximity or contactless cards, a newer and more common smart card system, require the card to only pass near the reader. Proximity cards use radio frequency (RF) signals to communicate information between the chip in the card and the reader unit. Use of a proximity card is more effective in reducing boarding time and typically has lower read-write maintenance requirements.[3]
- Hybrid cards, also called "combi-cards," are a combination of contact and proximity cards. The card contains both contact and contactless interfaces.

Technology can also help to coordinate billing and invoicing between human services agencies and transit providers. Paratransit is often funded by multiple agencies with unique billing, invoicing, and reporting requirements, which can be a considerable burden for all concerned. Automating these functions through the use of hardware and software systems can lead to significant gains in operational efficiency.

[3] Cutchin, Carli and Phyllis Orrick (2005). *ITS Decision: A Gateway to Understanding and Applying Intelligent Transportation Systems–Fare Payment Technologies.* http://www.calccit.org/itsdecision/serv_and_tech/Fare_Payment_Technologies/fare_payment_report.htm.

Safety and Security

Safety and security are addressed through a variety of technologies ranging from security cameras and personal handheld devices to vehicle tracking systems and silent alarms. Because fixed-route transit is not limited to a small community of users and drivers, security is typically more of a concern. Thus, for fixed-route transit to be a viable option for the transportation disadvantaged, it is crucial that safety and security be addressed in conjunction with accessibility.

Security cameras on-board vehicles, as well as at bus stops and rail stations, are perhaps the most obvious security technology employed. Though, not necessarily more effective at capturing or monitoring activities, easily visible cameras are effective at making surveillance known to the passengers. Live camera feeds from vehicles can be very helpful in emergency situations but require a wireless network connection with enough bandwidth to handle streaming video. Currently, most onboard cameras record to a tape or hard drive which is collected for review after an incident has occurred. At transit stops with traditional hardwire communications networks, it is more common to find cameras providing live video feeds.

Silent alarms, also referred to as "panic buttons," which can be operated by a vehicle operator, alert appropriate authorities to problems on-board the vehicle. Panic buttons are often integrated into the MDCs; however, many transit agencies prefer a more covert location for the panic button so the vehicle operator can activate it without being noticed. The emergency button needs to be easily accessible but not liable to false alarms through inadvertent activations. Typically, panic buttons are installed with an AVL system so that the exact vehicle location can be known the moment the alarm is activated. Another common feature of panic buttons is that, when activated, a covert microphone is turned on so that the dispatch office or authorities can hear what is happening on-board the vehicle.

Vehicle tracking systems can improve safety and security in a variety of ways. When a vehicle breaks down or when an incident occurs, the exact vehicle location assists authorities in arriving at the scene as quickly as possible.

Additional Technologies that Improve Mobility for the Transportation Disadvantaged

Assistive technologies, which are not generally considered ITS, provide greater autonomy to the transportation disadvantaged. Many of these technologies have not yet been widely deployed but show promise.

One type of assistive technology is the monitoring of cognitively disabled people. Lifeline, a research project supported by the Coleman Institute for Cognitive Disabilities at the University of Colorado in Boulder, is a wireless, GPS-based system that provides a vital link between caregivers and people with disabilities. Lifeline allows caregivers to monitor and assist their clients from a remote location. This system is particularly helpful for those with cognitive limitations who become easily disoriented or have difficulty making decisions. By carrying a small handheld receiver, a disabled person is able to make routine trips alone while maintaining a constant link with a caregiver.

Another type of assistive technology is acoustical "wayfinders" for the visually impaired. These personal assistive devices can alert users to intersections and crosswalks as they find their way to and from transit stops. The Remote Infrared Audible Signs (RIAS) directional wayfinding system from Talking Signs, Inc. requires the installation of transmitters placed at points of interest, such as ticket counters and boarding platforms. This system is further described in the section below on additional examples of specific technologies and applications.

The airline industry currently uses countertop devices that translate speech to text for facilitating communication between customers that are hearing impaired and customer service representatives. This type of device may also have applications in the transit industry at ticket counters or information centers. A talking directory system aids persons with visual impairment. The talking directory provides voice orientation to individuals within 2 feet of the kiosk. There are also auditory pathways which are a series of speakers installed along a predetermined route that are activated by pushing a button or, automatically, by a device worn by the traveler.

Examples of Useful Practices

Six agencies were chosen for in-depth examination because of their exceptional success in applying ITS and other technologies for coordinating human services transportation and improving mobility for transportation-disadvantaged populations. For each site, an emphasis was placed on how the site uses technology to improve coordination to accomplish its mission. Transit features that are of greatest importance to this segment of the population include:

- Flexibility of routes and schedules
- Easily understood and easily obtainable transit-related information
- Simple-to-use fare payment options
- Safety and security.

The focus sites for this study, their specific coordination strengths, and the approximate size of their services are shown in Table 2. Five of the six sites profiled—Wheels of Wellness[4], Cape Cod Regional Transit Authority (CCRTA), Flint Mass Transportation Authority (MTA), Ventura County Transportation Commission (VCTC) and TriMet—are transit providers or brokerages or both that use software for transportation coordination. (A transit provider provides rides to passengers; a brokerage contracts with other agencies to provide rides for clients.) A sixth site—Client Referral, Ridership, and Financial Tracking (CRRAFT)—is a software system, currently used by the New Mexico Department of Transportation Public Transportation Programs Bureau and several rural transit providers.

Site	Location	Type of Coordination	Size and Scope
Wheels of Wellness	Philadelphia, Pennsylvania	Coordination through brokerage	• Primarily a brokerage, but Wheels also provides transit services through its volunteer division • Large urban service area • Contract brokerage with eight carriers totaling 229 vehicles providing 5,000 door-to-door paratransit trips/day • 100 trips/day provided through Volunteer Division • Service limited to medical trips

Table 2 - Size and Scope of the Six Focus Sites *(continued on next page)*

[4] Wheels of Wellness provided non-emergency Medicaid transportation service from 1983 to 2005, and used ITS technologies to improve the management and delivery of that service. Currently, Wheels does not provide transportation for Medicaid trips and does not employ ITS. Nevertheless, Wheels staff learned many valuable lessons about the use of ITS in the paratransit setting that are discussed in this section.

Site	Location	Type of Coordination	Size and Scope
Cape Cod Regional Transit Authority	Cape Cod, Massachusetts	Coordination through mobility management	• Transit provider • Medium-sized system in a rural/urban area with high congestion during tourist season • 120 buses, about 1/3 are fixed-route • ~4,000 trips per week • Service includes both fixed-route and demand-response
Flint Mass Transportation Authority	Flint, Michigan	Coordination with decentralization	• Transit provider • Medium-sized system with fixed routes in the city and county-wide curb-to-curb service • 150 vehicles provide 2,000 demand-response trips/day
Ventura County Transportation Commission	Ventura, California	Coordination of accessibility on all modes	• Transit provider and brokerage • Medium-sized, multimodal, county-wide system • Service includes both fixed-route and dial-a-ride program • 113 contracted vehicles plus 33 directly operated vehicles
TriMet	Portland, Oregon	Coordination of accessibility on all modes	• Transit provider that brokers services for its medical program • Very large, urban, multimodal, three-county system • Fixed-route: 300,000 boardings/day including bus and light rail; 44-mile, 64-station light rail system and 93 fixed-route bus lines comprised of 660 buses • Paratransit: 210 buses and 15 sedans; 1 million rides/year • Medical transportation: 45 contract carriers; 1,400 medical trips/day • Ride Connection: 30 provider agencies; 250,000 rides/year
Client Referral, Ridership, and Financial Tracking	New Mexico	Coordination of client information among agencies	• Software system • Statewide, mostly small rural communities served • 27 rural transit providers • About 75-100 vehicles delivering paratransit trips

Table 2 - Size and Scope of the Six Focus Sites *(continued from previous page)*

Wheels of Wellness: Coordination Through Brokerage

Wheels of Wellness ("Wheels"), in Philadelphia, Pennsylvania, is a non-profit medical transportation brokerage that provides non-emergency medical transportation using primarily contract carriers.



Transportation Operations and Coordination

Wheels' Volunteer Division reimburses its own clients when they take public transit and reimburses people who give clients a ride. These drivers provide about 100 rides each day. Clients are encouraged to choose the less costly option of public transportation, if possible.

For trips provided outside of its Volunteer Division, Wheels manages every aspect of each trip except for the physical operation of the vehicles. Wheels operates the call center for scheduling trips, manages all of the routing and scheduling for the contract carriers, tracks carrier vehicles, handles customer complaints, and performs inspections of its contractor's operations. The MDCs and AVL equipment installed on contract carrier vehicles are owned and maintained by Wheels.

The system accommodates both regularly scheduled and previously unscheduled trips. The bulk (85 percent) of the 5,000 paratransit trips per day are subscription trips, meaning that they occur regularly each week on the same day and at the same time. There are, however, 200 to 300 changes per day to the subscription trips and 400 to 700 previously unscheduled trips per day that need to be accommodated in the new routing schedule. Routing and scheduling software has dramatically improved efficiency by reducing the number of manually scheduled trips. The routing and scheduling software has also improved coordination between Wheels and its contract carriers and has enhanced communication among the various departments within the organization. Finally, the tracking software is useful because clients frequently call for information on the location of their ride (Figure 3).



Figure 3 - A Dispatcher Responds to a Client's Request for Information

"One of the big advantages of the technology is that it allows us to identify who is really being served."

–Barbara Caballero
Fiscal Manager, Wheels

The MDCs on board each vehicle retain one hour of schedule/route information, so temporary outages or gaps in network coverage are buffered by one hour. The contract carriers' dispatch offices are networked to the Wheels system so they can view the routing and scheduling information. The carriers also receive paper copies of all manifests transmitted electronically. These hardcopy manifests can be used by carriers in the event of a prolonged network outage. Allowing carriers to view routing and scheduling information helps to keep the carriers well informed of operations, which in turn improves communication and promotes trust between the carriers and Wheels.

Wheels communications uses a wireless network. If the building that houses the Wheels operations center should be inaccessible due to an evacuation or some other event, Wheels managers and customer service representatives in the field could access their systems from anywhere within the wireless network coverage area.

Information Dissemination

The software used for routing and scheduling also has a module for billing which significantly reduces the effort required by Wheels staff and provides them with statistics that would not otherwise be available. According to Barbara Caballero, Fiscal Manager at Wheels, "One of the big advantages of the technology is that it allows us to identify who is really being served."

Reservationists at Wheels take requests by phone Monday through Friday. In addition, there is an interactive voice response system with an automated menu. Though the IVR system does not work well for all clients, it works very well for some agency representatives who become familiar with the system.

Safety and Security

It is not uncommon for a client to schedule a ride and then not show up. There is a maximum number of "no shows" within a period of time before riding privileges are suspended. Wheels notifies clients of changes, and technology plays an important role in the notification. By automating the process and tying it to a client database, letters are automatically generated and mailed to clients. Not only does this automation reduce the amount of manual labor involved, but it also reduces clerical errors, ensuring that the letters are timely and accurate.

All drivers undergo background checks and a verification of all required documents such as the driver's license. The driver information is then loaded onto an electronic ID card. At the beginning of each shift, a driver must swipe an ID card in the vehicle's MDC. The information from the ID card is then transmitted to Wheels where it is verified by a database to ensure that the driver's records are current. Wheels maintains detailed client and driver databases.

Once a driver's ID card has been validated, Wheels transmits the manifest to the driver's MDC over its wireless network. Because all pick up and drop off points are geo-coded with longitude and latitude coordinates and the vehicles are equipped with GPS-based AVL, Wheels is able to require that a vehicle is within a few meters of the geo-coded point before accepting the confirmation of a pick up or drop off.

To resolve complaints or conflicts that cannot be adequately resolved over the phone, Wheels has three customer service representatives that travel around the city by car with a cell phone and a laptop computer. The customer service representatives are able to access the routing and scheduling system at Wheels using its wireless network. They investigate complaints throughout the city and verify that vehicles in the real world match operations reported by the system.

Wheels was forced to discontinue the use of the onboard panic buttons due to an excessive number of false alarms. It is believed, however, that their removal has had little impact on safety because vehicles are very closely monitored and can be tracked at all times. In one instance, the system led to the quick discovery and rescue of a driver who became incapacitated and required immediate medical attention.

Wheels formerly used a Cellular Digital Packet Data (CDPD) wireless network. In 2005, however, Wheels replaced the CDPD network with an Evolution Data Optimized (EvDO) wireless network. The new system allows enough bandwidth to handle streaming video from in-vehicle security cameras, which gives Wheels the option to add yet another layer of security.

CCRTA: Coordination via Mobility Management

The Cape Cod Regional Transit Authority, in Cape Cod, Massachusetts, has provided both fixed-route and general public dial-a-ride service since the late 1970s. The 413-square-mile peninsula in eastern Massachusetts is considered rural, due to the designation of the Cape Cod National Seashore. However, during the summer, when Cape Cod's population triples to 600,000, the influx of tourist traffic causes extreme congestion. About a third of the population are older adults. CCRTA is responsible for providing Cape-wide transportation to the public for any purpose with door-to-door and traditional regional bus route service.



Transportation Operations and Coordination

In 1980, CCRTA was one of the first transit systems to deploy a computer-assisted scheduling and dispatching system. Using a minicomputer, software was written locally and was placed in the public domain. Over the years, the CCRTA upgraded its hardware and software platforms, implementing additional ITS components, such as MDCs, AVL (GPS-based), and a GIS. The software programs remain in the public domain. A dedicated radio system for data transmission and a local area network were deployed in the late 1990s.

All vehicles are equipped with GPS-based AVL and MDCs with a covert emergency button to alert authorities in case of emergency. The MDC provides real-time communications capabilities between the driver and dispatchers (see Figure 4). CCRTA currently uses conventional radio communications at a 450 MHz frequency with three radio towers to transmit data to the MDCs. A converter is needed to convert the signal from analog to digital to enable the MDCs to receive the data.

CCRTA has an impressive history of coordination within public and human service transportation. Since 1999, both fixed-route and paratransit data communications have used the same infrastructure.



Figure 4 - An MDC Provides Real-Time Communications

Once contracts are in place and individuals have been approved for services, the rides are assigned by the operations center using the custom-built CCRTA routing and scheduling software. By analyzing the locations of origins and destinations of Medicaid trips as well as CCRTA's paratransit services, the agency was able to move most of its Medicaid trips from single-ride taxi trips to less expensive shared-ride public paratransit trips.

Implementation of technologies has allowed dispatchers to serve more people, answer queries better, and maintain open communications between drivers, dispatchers, and clients. As stated by Larry Harman of Bridgewater State College's GeoGraphics Laboratory, "The tools are now available, so it is time to start pushing for the use of these technologies in transit operations. You really can't talk about coordination without talking about the science behind it. Unless you approach coordination in a systematic and verifiable way, which is best accomplished through the use of technology, it is just guess work and not really coordination in any useful sense of the word."

The CCRTA provides riders with several options for access to travel information. For example, CCRTA has three computer terminals in the Intermodal Center in Hyannis. One is a transit planner using Web-mapping, another shows estimated arrival times, and the third shows departure times. All of the bus location information is available on the Internet in real time and can be accessed by any Web-enabled device. There is also an IVR telephone system although some clients, especially older adults, do not like the menu system. While not often used, both a telephone line for foreign language speakers and a TDD/TTY line are available.

"...Unless you approach coordination in a systematic and verifiable way, which is best accomplished through the use of technology, it is just guess work and not really coordination in any useful sense of the word."

–Larry Harman
Bridgewater State College
GeoGraphics Laboratory

Information Dissemination

One of the best examples of information dissemination is the CCRTA transit travel planner, developed in 2000 (Figure 5). The planner uses a low-cost Web mapping tool. Up to three destination points can be entered by a user. These points are then matched with CCRTA fixed-route services. The user follows links to determine scheduling information. While the service is primarily used by tourists in the area, it is also used by persons who need to use transit to access a job. This feature offers the capability to plan for a childcare stop.

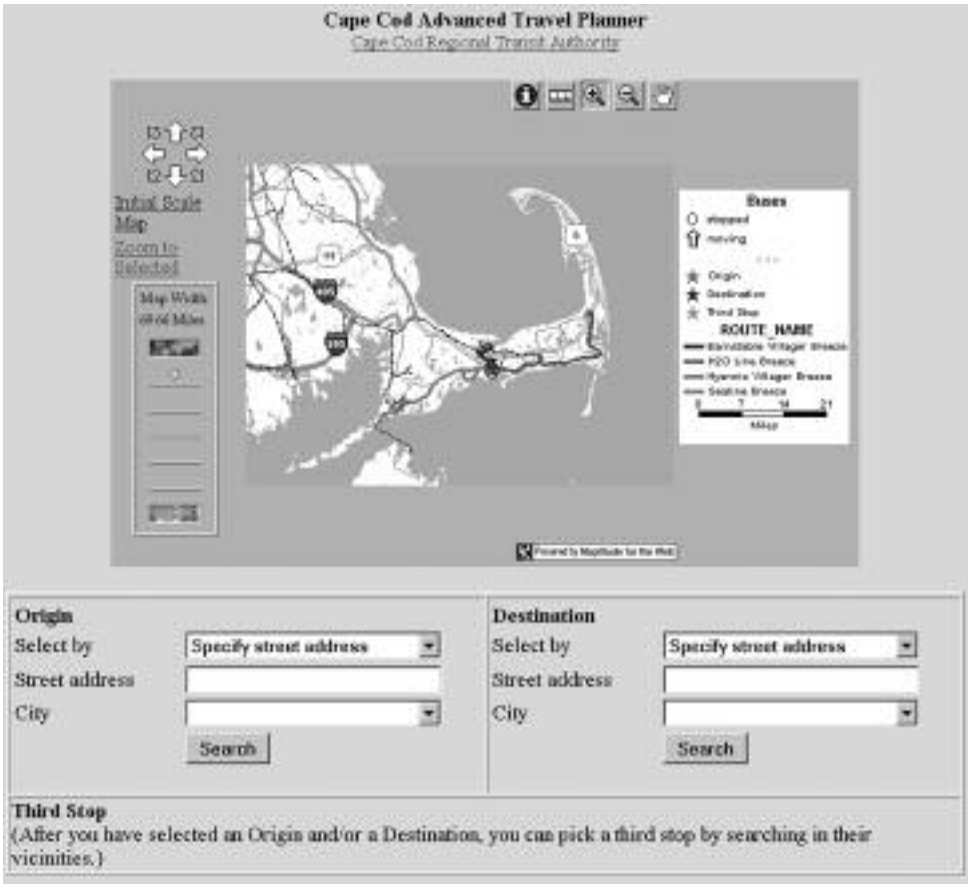


Figure 5 - Opening Screen of the CCRTA Travel Planner

Another means for riders to obtain information is the estimated time of arrival (ETA) tool. The ETA tool, which is only available on fixed routes, is accessible using PDAs, mobile phones, the Internet, and a spoken announcement available online. The locations of the buses are collected every 60 seconds using the AVL/MDC devices on the buses. These data are transferred via radio to a central location for processing by a custom-built prediction algorithm, which runs on a commercial software platform.

Flint MTA: Coordination with Decentralization

The Flint Mass Transportation Authority provides public transportation in the city of Flint, Michigan, and throughout the entire 636-square-mile area of Genesee County, which is home to over 400,000 residents. In addition to accessible fixed-route services, Flint MTA operates an extensive curb-to-curb paratransit service. Passengers who are unable to ride fixed-route transit due to a disability, and passengers outside the city of Flint where fixed-route service is not available, are eligible for the paratransit service. By following a regional ITS architecture and applying technology to support its goals, Flint MTA has been successful at obtaining outside funding, improving service, and becoming recognized in the community as a vital resource.



Transportation Operations and Coordination

Flint MTA's paratransit service, which began in 1975, was originally dispatched from a single large service center. By 1995, however, it became clear that changes were needed. The agency frequently fell short of customer expectations. Furthermore, many clients felt the paratransit service was an impersonal one because they spoke with a different receptionist and were picked up by a different driver for each ride. The nature of paratransit often requires attention to special needs, and many riders prefer to develop a personal relationship with their transit providers. To address these concerns, Flint MTA decentralized the single large service center and created 11 separate service centers throughout Genesee County. The following are benefits that Flint MTA experienced from the restructuring:

- Individual service centers are able to be more responsive to the communities they serve.
- Locating vehicles closer to where they are needed results in faster response times and reduced mileage per vehicle.

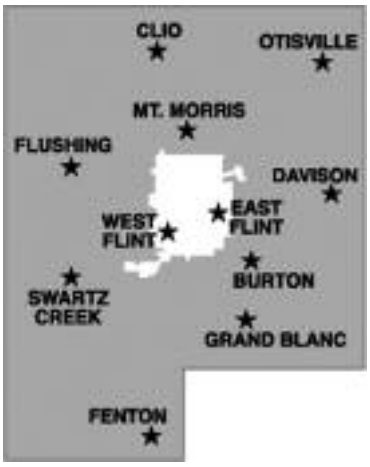


Figure 6 - Genesee County and its 11 Distributed Service Centers

- The smaller service centers provide operators and clients with the opportunity to develop personal relationships.
- Establishing a physical presence outside the city of Flint increases visibility and helps to build public support.

It was necessary for activities of the distributed service centers to be coordinated in order for them to function as a single transit provider that offers countywide service. Technology played a significant role in making such coordination possible.

Flint MTA opted for a single routing and scheduling software system to be used by all of the service centers. To facilitate coordination among the service centers, the agency chose a centralized structure for the software. This structure has several advantages:

- The central database ensures uniformity of data and data format.
- Each service center can easily view operational information from any other service center.
- A central client file, which can be viewed by all service centers, provides detailed information about each client within Genesee County.
- Software upgrades are easier, eliminating the need to upgrade 11 separate systems.

Although the vehicles from each service center operate primarily in their own service area, it is very important that the service centers coordinate vehicle usage as well as passenger information to facilitate smooth and efficient transfers between service areas. Wheelchair passengers are not required to transfer between vehicles when traveling across the county, so it is not uncommon for vehicles to travel outside of their service area.

A vehicle traveling outside its service area may pick up clients in other service areas as they pass through. This innovation helps to keep per passenger costs at a minimum but requires the service areas to coordinate their activities in order to realize this efficiency.

Aside from the important role technology has played in allowing Flint MTA to have decentralized service centers that are operationally integrated, the routing and scheduling software has also substantially increased the efficiency of scheduling rides. It is now possible for a service center to schedule 300 rides in just 3 minutes, leaving only a few that need to be scheduled manually. In addition, the technology is helpful in assigning rides to appropriate vehicles.

The software also has a module that allows for more efficient and flexible reporting of trips. Each of the service centers can generate reports by agency or from all service centers combined. Having a system that collects operational data in a centralized database has made it possible for Flint MTA to address inquiries more efficiently. The software ensures that vehicles with wheelchair lifts are assigned when necessary, while less expensive sedans are assigned to rides for which a wheelchair is not required.

VCTC: Cross-jurisdictional Coordination

The Ventura County Transportation Commission, in Ventura, California, administers a multimodal, multipurpose program. With only 18 employees, VCTC addresses customer, operational, planning, funding, and technology issues, and coordinates all of the transportation needs of Ventura County. VCTC's system consists of primarily vendor-supplied software. All projects are managed in-house by VCTC staff.



Transportation Operations and Coordination

VCTC is both a brokerage and a transit agency. In its role as a brokerage, VCTC coordinates with both public and private local area transportation services of all modes, including bus, rail, air, and even bicycle. VCTC also coordinates with other organizations that broker travel such as rideshare programs. In its role as a transit agency, VCTC operates VISTA, an intercity system consisting of 20 fixed-route buses, which connect cities in three counties. VCTC also operates 13 vans, which provide general public dial-a-ride service to rural areas and low-income communities. VCTC coordinates with five municipal transit providers operating 113 buses in the county. All vehicles are wheelchair-accessible, and paratransit dial-a-ride service exists within each city.

Information Dissemination

The VCTC travel planner is available by telephone and on the Internet. VCTC estimates that about 80 percent of households in the region have Internet access. Transit Router, a component of the travel planner, allows travelers to plan a transit trip, which may include multiple modes such as buses, trains, and ferries. Travelers specify an origin, destination, travel date and time, and other options. Transit Router provides a customized transit trip itinerary based on the traveler's input and needs, such as minimal walking or fewest transfers—features which are of particular benefit to the cognitively impaired as well as the physically disabled. The system also allows the client to request special accommodations, such as wheelchair accessibility. The travel planner is available in Spanish or English, for origins anywhere in Southern California.

All VCTC buses are equipped with GPS-based AVL, enabling VCTC to provide real-time bus location and approximate arrival times to passengers. Information is provided over the Internet, by telephone, and on signage at high-usage transit stops. The bus arrival system and software are managed by an outside vendor, which VCTC strongly recommends for transit agencies of its size. VCTC maintains the hardware and informs the vendor of any changes to routes, at which time the vendor updates the software. In addition to improving customer service, the software also provides an internal benefit to VCTC. The software produces reports that are helpful to VCTC staff in evaluating and improving agency operations.

Fare Payment

The fare payment option used by VCTC is a contactless smart card. Smart card processors are on all buses. VCTC coordinates with several different human services agencies to provide cards. The cards all look the same so if a card is subsidized by an agency such as a welfare program, it is not detectable at the individual level. About 15 percent of the smart cards are issued to persons with disabilities.

The cards can operate as an "e-purse" or a monthly pass. The e-purse card acts as a debit system. The e-purse is loaded with a specific value. Each time the card is used, the fare card reader deducts the cost of the trip from the card and records the identity of the transit operator for payment purposes.

The pass card provides unlimited usage for a calendar month. When this card is used, the ride and the identity of the transit operator are recorded. At the end of the month, the transit providers are reimbursed based on the percentage of rides provided.

Cards are sold at 20 different sites, called "points of sale," including the six social service agencies in the county, such as the one shown in Figure 7. Customers may add value to the card at a number of locations, including on board the bus or remotely by phone.

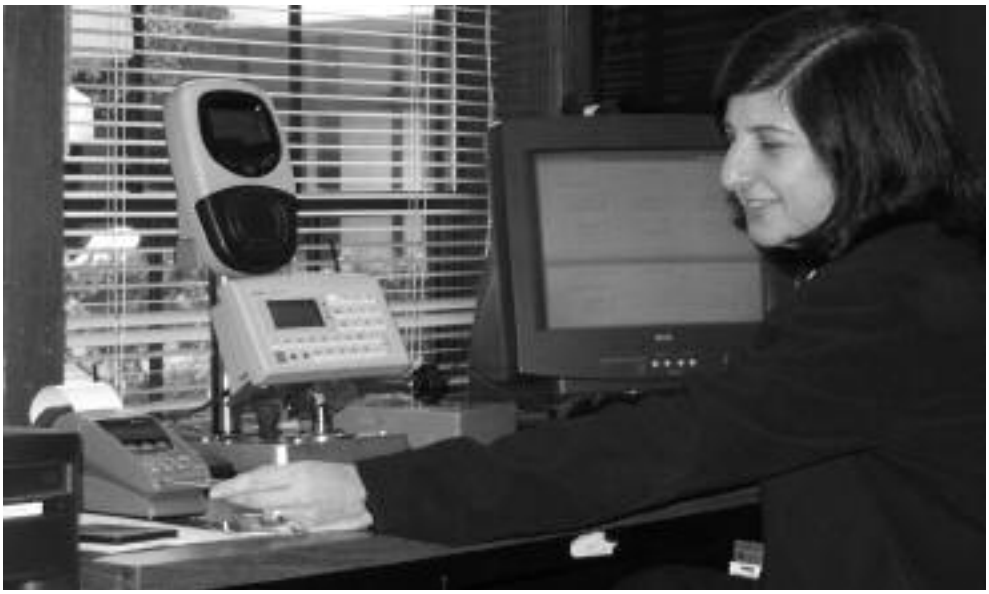


Figure 7 - Smart Cards Are Programmed at "Point of Sale" Locations

The smart card is valid across the entire county and among all of the transit providers. Although VCTC first pursued the smart card system because of its mobility benefits, the agency discovered that it benefited operators as well because it enabled people to get on the bus faster. Placement of the smartcard reader and fare box in convenient locations is important for speeding up the boarding process (Figure 8). Passengers may pay a regular fare or use a smart card. For passengers with smart cards, the processor reads from the card when the passenger boards the bus. Data are downloaded from the buses nightly using a wireless communications system at the bus maintenance facilities, and the purchase requisitions are reconciled using the database.

In 1995, VCTC prototyped a smart card that was unsuccessful. The report, *Ventura County Fare Integration: A Case Study*,[5] explores VCTC's

[5] U.S. DOT (2001). *Ventura County Fare Integration: A Case Study.* http://www.itsdocs.fhwa.dot.gov/jpodocs/repts_te/13479.html, EDL# 13479.

"Success in the world of transit can be measured in three ways: technical success, political success, and consumer success. The tracking and information dissemination technology has been a huge success in all three of these areas."

–Steve DeGeorge
VCTC Director of Technology



Figure 8 - Smart Card Reader and Fare Box

implementation of its 1995 smart card system and the many lessons it learned through the experience. While the system was quite popular among transit riders, the transit providers did not believe they were being reimbursed fairly. By analyzing the failures of the first smart card deployment, VCTC was able to make the current implementation successful to both customers and transit operators, although its public acceptance has been hindered to some extent by its association with a cumbersome passenger counting system. According to Steve DeGeorge, VCTC Director of Technology, "Success in the world of transit can be measured in three ways: technical success, political success, and consumer success. The tracking and information dissemination technology has been a huge success in all three of these areas. The smart card has been a huge success technically and from a consumer point of view. From the political viewpoint, its success is questionable, because it has been tainted by its association with the passenger counting technology. To ensure greater use, better marketing is needed."

TriMet: Coordination of Accessibility on All Modes

TriMet is a municipal corporation providing public transportation for much of the three counties in the Portland, Oregon, metropolitan area. TriMet operates a comprehensive transit network including a Metropolitan Area Express (MAX) light rail system, fixed route bus lines, and paratransit. Additionally, TriMet contracts with other organizations to supplement regular services.



TriMet has one database format used by multiple applications. Even when purchasing new application software, TriMet stipulates that the software must match the existing database structure. TriMet has written many application programs in-house and is a proponent of open source development.

Transportation Operations and Coordination

TriMet uses many different types of vehicles—including light rail trains, fixed-route buses, small paratransit buses, and sedans—to provide a variety of services, such as shared-ride paratransit, medical trips, non-profit community transportation, and work shuttles. TriMet found coordination among the various modes and functions was a significant challenge. In the late 1990s, the agency consolidated fixed-route bus and light rail operations in order to achieve better coordination between the dispatch services of these two modes.

TriMet's Fixed-Route Service

All MAX trains and TriMet buses are wheelchair-accessible. Buses are low-floor kneeling buses or are lift equipped. Low-floor kneeling buses are more easily accessible and more reliable than buses with the more complex lift mechanism. The ramps and lifts on buses and trains generate data when deployed. With the data generated from lift and ramp deployments, TriMet can easily determine which routes require the most deployments and assign the new low-floor buses to those routes. The older lift type bus serves those routes where lift or ramp

services are rarely used. The data also help TriMet determine equipment and resources that are needed in the future and provide an indication of the client base that is served. TriMet's emphasis on accessibility has made the fixed-route service a valuable alternative to paratransit for many people with disabilities (Figure 9).



Figure 9 - A Passenger with Her Guide Dog Boarding a Fixed-Route Bus

TriMet's LIFT
LIFT is TriMet's program that addresses regulatory requirements of the Americans with Disabilities Act (ADA), delivering door-to-door shared-ride service for pre-qualified riders who are unable to use TriMet's fixed-route service. LIFT rides may be for any purpose. LIFT serves riders anywhere within 3/4 mile of all TriMet bus routes and MAX lines. The software used in scheduling, routing, and coordinating the rides is owned by TriMet but is not the same software used by the fixed-route service.

TriMet's Medical Transportation Program
The Medical Transportation Program is completely separate from LIFT or the fixed-route service. The Medical Transportation Program uses contract carriers and software developed in-house to manage the operation. Coordination involves TriMet, the state, the contracted carriers, and social services agencies.

TriMet automates the nightly download of the state's eligibility file to ensure that each morning the most current eligibility list is used. Ride requests are called in by telephone and a receptionist at TriMet enters the request into the software system. The software, which also handles invoicing and billing, was modified by TriMet personnel from outdated commercial software. TriMet coordinates with the contract carriers over the Internet through a secure password-protected Web application. This Internet-based program allows the carriers to perform the following operations:

- View trip scheduling information
- View trip details for any ride listed in the schedule
- Download trip scheduling information into a tab-delimited text format
- Create and delete invoices
- Archive information about each trip such as cost, driver name, and actual pickup time
- Create detailed and summarized billing reports.

Ride Connection
The non-profit Ride Connection, which offers assistance to people with disabilities and senior citizens without other transportation options, coordinates community-based transportation within a network of more than 30 provider agencies. TriMet contracts with Ride Connection to coordinate services that supplement regular TriMet services in the three-county region. Unlike programs operated directly by TriMet, agencies and organizations affiliated with Ride Connection use a combination of volunteers and paid staff.

JARC funds were used in combination with other funds to purchase the vendor-supplied software used for scheduling rides. The software saved about half of the time the scheduler usually took to schedule rides. The software also helped to maximize the number of shared rides through the use of automated scheduling features. Dan Marchand, TriMet Transportation Planning Department, praised the reporting feature in the software and stated, "All this adds to our ability to deliver a quality service at a time when funding is flat and adding employees is not an option. After we have more experience with the software, we are confident it will also have a positive impact on our overall cost per ride."

Information Dissemination

Tracking Technology

Transit Tracker is TriMet's custom-built system that provides real-time bus and train arrival times. Transit Tracker is available over the Internet, by telephone, and on signage at high-usage transit stops. At some stops, the signage includes a text-to-voice audible announcement.

Even though Transit Tracker is not used for paratransit, it is used extensively by transportation-disadvantaged populations. Many people with disabilities use TriMet's fixed-route service because of its convenience and reliability. The popularity of Transit Tracker can be measured in the number of phone calls that are logged by the system—over 6,000 daily.

On-board Displays and Audible Enunciators

All MAX trains have audible announcements of stops. In addition, there are large liquid crystal display (LCD) signs that display the next stop on 75 percent of the rail cars. While this technology is of great benefit to all riders of TriMet, it is particularly helpful for those who are blind or visually impaired. TriMet is currently in the process of installing similar technology on its fixed-route buses.

"Like any other blind person, I am looking to be as independent as possible, and this device is a tool for independence."

–Frank Synoground
Oregon Commission
for the Blind

Wayfinding Devices

TriMet data supports a new technology that allows the blind or visually impaired to access transit information in either Braille or audio format. Information is accessed through a portable note-taking system frequently used by the blind (Figure 10). Frank Synoground, a manager with the Oregon Commission for the Blind, notes, "Like any other blind person, I am looking to be as independent as possible, and this device is a tool for independence." Mr. Synoground continues, "We see this not only as a way to offer greater independence but also as a savings to our agency."



Figure 10 - Frank Synoground Demonstrates the Use of His Wayfinding Device

CRRAFT: Coordination of Client Information Among Agencies

CRRAFT– Client Referral, Ridership, and Financial Tracking – is an Internet-based transit management software program. The goal of CRRAFT is to facilitate coordination between transportation providers and human services agencies in New Mexico. CRRAFT was developed to help agencies satisfy the requirements of multiple funding agencies and programs. CRRAFT is currently used by the New Mexico Department of Transportation (New Mexico DOT) Public Transportation Programs Bureau and several rural transit providers in the state.



CRRAFT was designed through collaboration between the New Mexico DOT, the U.S. DOT, and the New Mexico Department of Human Services. Developed by the University of New Mexico's Alliance for Transportation Research Institute, CRRAFT integrates human service client referral and service requirements with rural public transit operations and medical providers. CRRAFT generates financial and client tracking reports that meet each funding agency's criteria.

The CRRAFT software does not schedule paratransit trips itself. Instead, it provides transit agencies with a log of scheduled trips that is used in generating invoices to send to funding agencies.

Transportation Operations and Coordination

CRRAFT facilitates communication and provides coordination between transportation funding agencies and rural transit service providers. This coordination includes referrals, recordkeeping, trip validation, and reporting. CRRAFT was designed to ensure that these agencies have all the information they need to provide quality service to their clients and also to produce accurate reports, which ensure correct billing and record keeping.

CRRAFT was developed in order to achieve several objectives, namely to improve paratransit service, increase the accuracy of invoices sent to funding agencies, and reduce the time funding agencies spend collecting information on transit providers. An independent evaluation of CRRAFT published in 2005 concluded that the system was successful in increasing accuracy of invoices and reducing funding agencies' data collection burden. Service improvements were expected through more efficient scheduling, fewer unauthorized trips, and reduced operating costs. However, there was disagreement among transit providers that participated in CRRAFT as to whether or not its use contributed to such service improvements.[6]

[6] U.S. DOT (2005). *National Evaluation of the New Mexico Client Referral, Ridership, and Financial Tracking (CRRAFT) System: Final Evaluation Report*. http:www.itsdocs.fhwa.dot.gov/jpodocs/repts_te/14175.htm, EDL#14175.

Currently, clients have the ability to transfer from one transit system to another on the same trip and still count the ride as a single trip. To schedule a trip, a client calls the customer service representative at the funding agency and requests the trip; then the customer service representative sends the referral to a transit provider and requests the pickup.

An integrated smart card component was developed and tested in 2005. The smart card system is expected to facilitate ridership and financial tracking functions.

The functionality provided by CRRAFT is unique. It is the only Internet-based statewide coordination tool in existence. While CRRAFT is a Web-based system, it is password protected. Only authorized users, i.e., transit and funding agencies, may access the site. Because it is Internet-based, CRRAFT is available for use at any time by authorized users. Thus, transit providers are able to perform their scheduling at a time that is most convenient for them. This availability may be particularly helpful for small rural transit providers with limited resources and minimal staff.

Additional Examples of Specific Technologies and Applications

In addition to the six examples presented earlier, four other sites have used creative applications of ITS and other technologies in order to better serve transportation-disadvantaged populations.

RYDE: Goal Setting Using the National ITS Architecture

Although Reach Your Destination Easily (RYDE) is centered in the city of Kearney, Nebraska, it is a regional system involving several primarily rural counties. Coordination with health systems, transportation agencies, police and sheriff departments, the public schools, and others is critical.[7] RYDE used the National ITS Architecture regional development process to coordinate these diverse partnerships.

RYDE personnel found that developing, implementing, and maintaining a regional ITS architecture were integral steps in the process of their ITS project. The thought processes involved in developing an architecture helped planners communicate assets, relationships, and desired outcomes. According to David Ripplinger of North Dakota State University's Upper Great Plains Transportation Institute who evaluated the Kearney system, "It is both the process that Kearney has followed and the mindset of its organization that are 'cutting-edge,' especially for a system of its size."

OmniLink: Fixed Route Flex Service Aids All Riders

The Potomac and Rappahannock Transportation Commission (PRTC) provides transit service in the area about 25 miles southwest of Washington, D.C. Developed in 1995, OmniLink uses an innovative, non-traditional approach to transit service, blending fixed-route service with demand-response flexibility. OmniLink uses ITS technologies to provide mobility for both the general public and transportation-disadvantaged populations with a near-real-time flexible route service that eliminates the need for a separate paratransit system.

OmniLink has specific routes and designated stop locations. However, buses will travel up to 3/4 of a mile from the fixed route to provide demand-response service. OmniLink's operating costs are significantly lower than is usual for systems operating separate fixed-route and paratransit services.

ITS technologies are used to provide the flexible service. OmniLink uses GPS-based AVL and MDTs to track vehicle location, count boardings and alightings, and provide on-time performance feedback (both real-time and predicted) to dispatchers and operators. The system automatically detects each vehicle's arrival at and departure from bus stops and transmits that information to a central dispatch location.

"It is both the process that Kearney has followed and the mindset of its organization that are 'cutting-edge,' especially for a system of its size."

–David Ripplinger
North Dakota State University

[7] Battelle (April 2003). *Regional Transit ITS Architecture, Kearney, Nebraska.* Federal Transit Administration in cooperation with Federal Highway Administration, Nebraska Department of Roads, and RYDE Transit.

MUNI: Remote Infrared Audible Signs

A type of technology that can provide mobility assistance for the visually impaired is the Remote Infrared Audible Signs directional wayfinding system[8] which has been deployed in key facilities of the San Francisco Municipal Railway (MUNI) and other sites around the country. In contrast to signs that merely convert on-screen text into an audible message which is broadcast through speakers to the general public, the RIAS system is targeted to only those who would benefit from the system. This system provides detailed and precise directional information that allows a blind traveler to accurately and discretely navigate through areas where the system is deployed, as shown in Figure 11.

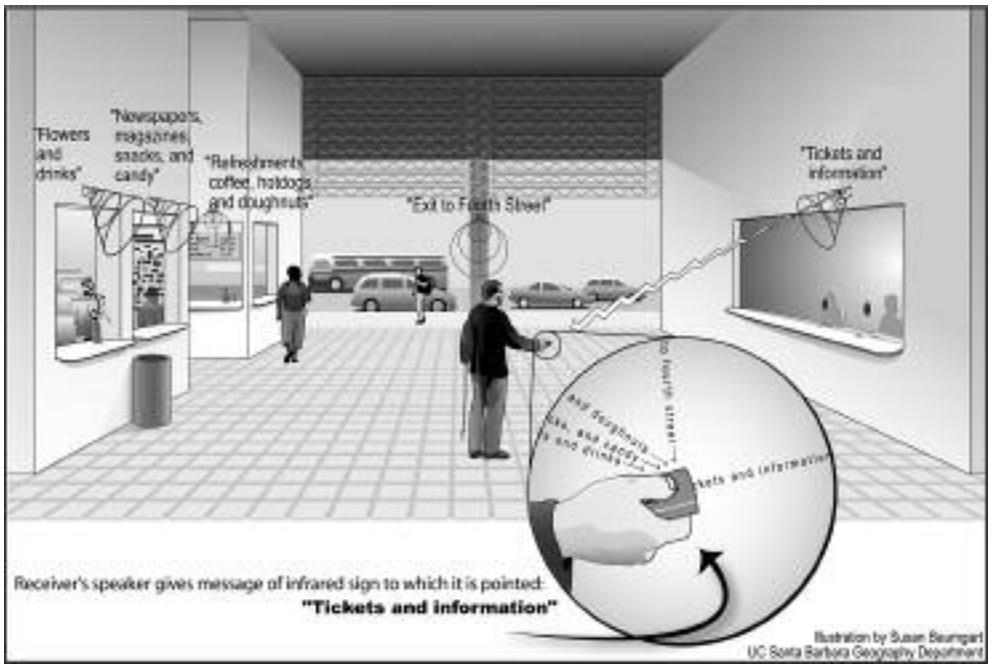


Figure 11 - A Schematic of the RIAS System

Infrared transmitters, placed in strategic locations, provide audible directional information to those carrying a special hand-held receiver. The hand-held receivers are used much like a flashlight in that they must be pointed in the direction of a transmitter in order to "see" it and receive the message.

Because the coverage area for this type of system is crucial, a deployment within a transit system is most likely to be successful if it is part of a citywide installation plan which includes not just public transit vehicles and facilities, but also street signs, crosswalks, and other public buildings. As of 2005, the transmitters were installed at more than 22 sites throughout San Francisco, including transit stations, bus shelters, railway platforms, public facilities, and private facilities such as banks, hotels, and shopping centers.

[8] Talking Signs, Inc. (2006). *Talking Signs, Infrared Communications System*. http://www.talkingsigns.com.

In addition to reaching a critical level of deployment, there also needs to be a significant population of potential users to merit the costs of installing the transmitters. Large urban transit agencies may find the deployment costs to be within reason when measured against the benefit provided to the visually impaired or cognitively disabled communities.

SMART: Shared Resources

The Suburban Mobility Authority for Regional Transportation (SMART), headquartered in Detroit, Michigan, coordinates activities within a three-county area to provide mobility on a regional basis.

SMART has a license for unlimited use of scheduling software. This license allows the agency to provide access to the software to smaller agencies in the region, many of which could not afford scheduling software on their own. SMART houses the hardware and software at a central site, which serves as a telecommunications and computational hub for the entire system. The community agencies access the software over the Internet to schedule their own or one of SMART's vehicles. In addition to facilitating scheduling, the software's reporting function has been a tremendous benefit to the smaller agencies, providing them with quantitative data on who is using paratransit services and for what kind of trips.

Detroit hospitals can use the shared software to book rides for patients. This process ensures that the patient has transportation to the doctor's appointment prior to scheduling the appointment.

With the centralization of technology in a single location for such a large area, SMART has had to consider issues such as scalability and reliability. To address these issues, SMART's system, including its telephone, bandwidth, and computational capabilities, is readily scalable to expand its capacity if needed.

Cross-Cutting Findings

This section presents an analysis of the findings from the sites profiled in this report. Table 3 shows the technologies used at the six focus sites for transportation operations and coordination, information dissemination, fare payment and billing, and safety and security.

Site Name	Transportation Operations and Coordination	Information Dissemination	Fare Payment and Billing	Safety/Security
Wheels of Wellness	GIS customer geo-coding, GPS-based AVL vehicle tracking, and MDCs allow for last-minute route and schedule alterations. Backup systems and wireless network allows Wheels management to access the system remotely if necessary.	• Menu-driven IVR phone system • Automated system for issuing status letters	• Data from billing software used by Volunteer Division to reimburse drivers who give clients a ride and reimburse clients who use public transit	• ID cards for drivers and escorts • GPS-based AVL
CCRTA	GPS-based AVL and MDCs ensure coordination between drivers and dispatch, allowing for changes in schedule.	• Web-based real-time interface • Three public use centrally located terminals • TDD/TTY	• Vehicle tracking data used to justify billing allocation among towns served	• Silent alarm system • GPS-based AVL
Flint MTA	All 11 paratransit service centers in Genesee county share operational information and centralized client file, allowing for seamless interoperability of routes, schedules, and trips.	• Static information available on the Internet	• Transit passes • Electronic fare boxes accept prepaid cards	• Surveillance cameras on fixed-route buses • GPS-based AVL
VCTC	Real-time vehicle location system provides information online, allowing passengers to modify their schedules.	• Travel planner via Internet or telephone • Real-time bus location information via Internet, telephone, and at key bus stops	• Contactless smart cards	• SAFE cellular telephone program • Surveillance cameras • GPS-based AVL

Table 3 - Technologies Used at the Six Focus Sites *(continued on next page)*

Site Name	Transportation Operations and Coordination	Information Dissemination	Fare Payment and Billing	Safety/Security
TriMet	For paratransit operations, AVL in combination with routing and scheduling software maximizes efficiency. For fixed-route operations, accessibility and coordination with other programs provide three-county coverage.	• Travel planner • Real-time vehicle location • On-board displays and audible enunciators • LCD displays at key stops • Information available via telephone and Web-enabled devices	• Separate software used for record keeping, i.e., billing and invoicing, for the medical and paratransit functions	• Surveillance cameras • Silent alarm system • GPS-based AVL
CRRAFT	The software is Web-based and accessible only by transit and human service agencies. Clients can switch from one transit provider to another on the same trip and the trip is still counted as a single trip.	• Information sharing is limited to funding agencies and transit providers.	• Contactless smart card system integrated with CRAAFT streamlines and automates ridership tracking, reporting, and billing.	None

Table 3 - Technologies Used at the Six Focus Sites *(continued from previous page)*

Transportation Operations and Coordination

All six of the focus sites use technology for coordination, although the applications differ considerably. Wheels of Wellness, Flint MTA, VCTC, and TriMet all use vendor-supplied software, although they do not all use the same software vendor. TriMet's paratransit service, regional dial-a-ride service, and fixed-route service use three different vendors. CCRTA and CRRAFT use custom-built software specifically developed for their requirements. TriMet also uses custom-built software for its Medical Transportation Program. (See the list of vendors in the Resources section.)

Wheels of Wellness coordinates medical trips using eight contract carriers, drivers paid by Wheels' Volunteer Division, the Philadelphia fixed-route multimodal system, and taxis. Coordination also includes trip authorizations and approval of treatment centers by appropriate human services agencies. Through the use of routing and scheduling software,

Wheels reservationists are able to coordinate their activities with staff who track the vehicles in real time. This coordination allows Wheels to respond more quickly to incidents, unscheduled changes, and last-minute trip requests. As a general rule, reservations are made one day in advance. However, Wheels' success in accommodating same-day requests is enhanced by knowing, through the AVL system, the real-time location and status of all available vehicles.

CCRTA coordinates fixed route and paratransit service. One innovative use of technology is a hybrid paratransit-fixed route service for medical trips to Boston area hospitals. CCRTA provides Cape-wide curb-to-curb service with no restrictions on the trip purpose. Based on needs identified through data mining, the CCRTA adjusts routes and schedules.

Flint MTA's distributed network of 11 service centers for paratransit trips has enabled Flint MTA to be more responsive to local needs and more accommodating to individual clients. A centralized routing and scheduling system has made it possible for the service centers to coordinate their operations and provide a seamless coverage of service throughout Genesee County.

VCTC is a small office with coordination responsibilities over public and private carriers as well as all transportation modes and issues in Ventura County.

TriMet emphasizes accessibility on all modes and coordinates data from multiple human services programs into a centralized database. The data generated by TriMet's system are used to determine high levels of use by the transportation disadvantaged to identify stop areas that need improvements or to determine where accessible pathways are needed. Data are also used for the Transit Investment Plan, which helps to ensure transit equity for transportation-disadvantaged populations. TriMet's Stop and Amenities database contains information about every bus stop and rail station in the TriMet system. This amenities database includes photographs and descriptions of each stop, which provides TriMet the ability to quickly assess incidents that occur at stops and to plan for improvements without having to physically visit every site in question. TriMet's system for collecting, organizing, storing, and analyzing data maximizes current resources and helps TriMet coordinate efforts with other agencies and organizations.

CRRAFT's software coordinates communications between human services agencies and transportation providers.

PRTC's OmniLink found that use of ITS technologies provided better, more dependable schedules, improved customer service, helped with planning, promoted better staff utilization, and increased productivity.

Information Dissemination

Easily accessible transit information is critical to achieving high levels of ridership. It is important to recognize that there is a wide variation of how people acquire information and this variability is even more pronounced among transportation-disadvantaged populations due to physical, cognitive, or financial limitations. However, technology can greatly facilitate the dissemination of transit information by addressing this need for multiple options.

Wheels of Wellness uses existing data to automate the printing and mailing of warning notifications to riders who are in danger of or have lost ridership privileges.

CCRTA's Web-accessible transit planner allows for a third destination, for example, a childcare stop. Real-time bus location information is accessible via home computer or any Web-enabled device such as cell phones and PDAs. In addition, three public use terminals, located at the Hyannis Intermodal Center, display real-time traveler information including arrivals and departures.

Flint MTA routes, schedules, fares, and other static information are available on the Internet.

VCTC's transit planner is available on the Internet or via telephone through a toll-free number. The planner, which is available in English and Spanish, allows for criteria-based itinerary planning, such as shortest walking distance. Custom help is available for trip planning and negotiating the system.

VCTC's bus tracking system has been beneficial to both passengers and the agency itself. Customers like the system because it can reduce the amount of time they need to spend at the bus stop. This feature is particularly important for older adults and people with disabilities who find it difficult to wait outside for long periods of time. Since installation of the signs, the number of people calling to inquire about the arrival time of their bus has decreased. The agency has benefited from the system's ability to monitor operations. The system allows VCTC to easily investigate complaints such as "The bus left my stop early." In addition, the system generates data that enables operators to revised schedules and routes as needed. With passengers and operators depending so much on the data, data integrity is a key factor in the system's success.

TriMet data, including real-time vehicle location, routes, schedules, and a trip planner, are available using any Web-enabled device or by regular telephone in multiple languages. Most rail cars and some buses have on-board displays and audible enunciators. In addition, a data interface for wayfinding devices has been implemented.

Fare Payment and Billing

CCRTA was awarded a grant to deploy an electronic fare card system that was initially designed to alleviate congestion during the summer months. Because the fare cards were provided to hotels for guests and hotel staff, the electronic fare payment program proved to be a very successful job access program for the low-income hotel workers. In addition, the program had a lasting effect on transit use as a whole. This lasting effect can be attributed to the fact that hotels were required to instruct their guests on how to use the transit system and the online Travel Planner. Furthermore, a high percentage of guests return to the same hotel year after year, thus providing the Travel Planner with a large seasonal user base.

VCTC has a fully deployed contactless electronic fare card system that is used by multiple transit carriers and managed at VCTC. This system is helpful to all passengers but particularly for the transportation disadvantaged who may have difficulty handling money due to a disability. The system also reduces boarding times and provides ridership data. The subsidized fare cards are visually indistinguishable from regular fare cards for increased discretion among passengers. The local university also issues smart cards to students, faculty, and workers. The university pays VCTC a lump sum for the year and VCTC reimburses the transit providers.

TriMet uses fare tickets rather than fare cards. TriMet's ticket vending machines are networked so they can be monitored remotely to ensure that the machines are properly stocked and operating correctly. This feature is particularly important to those with limited mobility who cannot easily go in search of another machine if the one they first encounter is out of stock or out-of-order. Maintenance of the ticket vending machines is performed by TriMet employees, while revenue collection and ticket stock refills are performed by a contracted security company. In addition, TriMet uses an Internet-based system for coordinating rides and sending invoices to funding sources for rides taken under the Medical Transportation Program.

Safety and Security

One of the most important safety features is that of knowing where the vehicles are located at all times in case of emergencies. Wheels of Wellness, CCRTA, Flint MTA, VCTC, and TriMet all use some type of vehicle tracking technology.

Wheels of Wellness provides for the safety of their clients by ensuring that all of the contract carriers' vehicles are performing their trips exactly as specified through vehicle tracking. There is also an automated system that validates the credentials of each driver at the beginning of each shift, comparing the driver ID card with a driver profile database that is maintained at Wheels.

CCRTA has a silent alarm system on all of their vehicles as well as GPS-based vehicle tracking. Fixed-route buses have on-board surveillance cameras, as do key bus terminals.

VCTC has on-board security cameras for the buses that are maintained and operated by VCTC. VCTC also tracks the position of the other transit carriers' buses in Ventura County. VCTC supports a SAFE cellular telephone program for those who drive independently but cannot use roadside call boxes due to a mobility impairment. The program provides free cellular telephones that are programmed to dial only 911 so that use is restricted to reporting emergencies and requesting assistance. To increase the security of transit riders, VCTC provides a guaranteed ride home program.

TriMet has cameras on-board their light rail and fixed-route buses that record to tape. Streaming video from selected rail stations is monitored from a control room. TriMet also has the ability to track its vehicles in real time, and its vehicles are equipped with a silent alarm.

Lessons Learned

Common Lessons Learned

The following are lessons learned that were common to many of the sites.

- **Technologies should be phased in incrementally, fixing the problems with each technology before adding another layer of complexity.** For example, it took Wheels of Wellness about three years to fully integrate the routing and scheduling software with the MDCs and vehicle tracking equipment. CCRTA noted that key infrastructure elements (e.g., a communications network) need to be in place prior to deployment. Flint MTA deployed its system incrementally, installing the system separately at each of its 11 service centers.
- **Training of staff, operators, drivers, and users is crucial to allay concerns and ensure complete and accurate use of the system.** CCRTA discovered that the best way to improve data integrity and completeness was to train everyone on how to use the system and—more importantly—why correct use was essential. Flint MTA recommended the use of vendor-supplied training and on-site support when implementing vendor-supplied software. Wheels of Wellness trained the drivers for each contract carrier together and then integrated that carrier into the system immediately while the training experience was still fresh. VCTC strongly recommends training as an opportunity to discover defects in the system. Several agencies noted that vehicle operators were apprehensive about being monitored at all times with tracking equipment. However, over time, drivers learned to appreciate the system. For example when clients complained that a driver was not on time, the tracking software could determine the legitimacy of the complaint. At CCRTA, two drivers were cleared of sexual harassment charges as a result of the tracking data produced by the system.
- **Regular meetings between system providers, subcontractors, policy makers, special interest groups, and agency managers allow stakeholders to share problems and ideas and to build consensus.** The CRRAFT system, for example, did not include certain capabilities that were desired by some transit agencies. Because of miscommunication concerning these capabilities, CRRAFT received mixed reviews of its usefulness. Wheels of Wellness found that regular meetings to share operational concerns and ideas have been very valuable.
- **A commitment to data quality is essential.** ITS technologies can produce a massive amount of data, so the challenge becomes management and analysis of those data. There is always more than one use for a data set. Mining and reusing the data can lead to insights which form the basis for operational improvements. At CCRTA, for example, a dedicated database manager was hired. This manager checks for anomalies in the data, at which time the issue is flagged and investigated. Data are also used to optimize route efficiencies. TriMet uses data to identify areas of high usage levels by the transportation disadvantaged. This information can then

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–Robert Foy
General Manager,
Flint MTA

determine stop areas that need improvements or to determine where accessible pathways are needed. TriMet also mines the data to plan for capital improvements that helps to ensure transit equity for transportation-disadvantaged populations.

- **If vendor-supplied software is chosen, it is critical to look at the vendor's longevity and integration capability, avoid excessive modifications of the software's functionality, and insist on on-site training and support.** Flint MTA's first implementation of vendor-supplied software failed because the agency insisted on an excessive number of site-specific modifications to the software. These modifications made software updates and maintenance difficult and expensive. The second time Flint MTA implemented the software, using the same vendor, the effort was successful because the staff made a commitment to work within the scope of the software. According to Robert Foy, General Manager, Flint MTA, "The first time, we did not want to change anything about the way we did business and insisted that the software had to be tailored to our routine operations. This frustrated the software vendor and led to a one-of-a-kind syndrome where the system was so unique that upgrades were very difficult." VCTC noted that use of vendor-supplied software was their only option because their office staff is limited and had no time for in-house development.

Site Specific Lessons Learned

At several stages in the system development process—planning and design, implementation, and evaluation—sites discovered certain keys to their success, which are summarized below.

Planning and Design

- **Wheels of Wellness—Be creative when funding the deployment of a new system and the transition to ITS.** Because direct funding was not available, Wheels acquired a loan from a bank to purchase and install the system. Wheels then assessed a fee on the carriers for lease of the ITS equipment on the vehicles. The carriers knew about the fee in advance and increased their charges accordingly. In this way, the state of Pennsylvania ended up funding the system by paying for the increased operating expenses per trip.
- **CCRTA and CRRAFT—Ensure that there is a strong commitment from the staff and policy makers to make the system work.** It is essential that all stakeholders are aware of what the system will and will not do, and that all critical operational needs are addressed in the system design.
- **Flint MTA—Develop a master plan, including a cost estimate.**
- **Flint MTA—Apply the same standards among all systems with which there will be coordination to ensure maintainability and consistency.**
- **VCTC—Weigh the value of integrating separate technologies.** Successful implementation of smart cards has been a difficult process because VCTC decided to integrate passenger counting with the

smart card technology. Although the data integration has presented significant problems, passenger counting is important for route management and for Federal reporting requirements. VCTC considers the delays in implementation worth the effort.

- **TriMet and RYDE—Follow the National ITS Architecture and associated standards as much as possible.** The process of developing a system architecture on the regional and project level helps diverse stakeholders communicate with each other about their assets, relationships and desired outcomes. In addition, the use of common standards helps ensure compatibility among equipment purchased by different organizations.
- **TriMet—Use a common database format for all system data.** TriMet's use of one database structure with multiple applications saved the agency money by reducing the time needed to develop new applications, eliminating the need for training on multiple software applications, and reducing the need for software maintenance and upgrades. TriMet's system for collecting, organizing, storing, and analyzing data allows the agency to maximize current resources and plan for future growth. The system also enables TriMet to be more efficient in its coordination with other agencies and organizations.
- **OmniLink—Consider combining paratransit and fixed routes.** The resulting flexibility is of value to all transit riders, not just the transportation disadvantaged.
- **MUNI—Assess the level of deployment needed to ensure usefulness of new technologies to potential users.** Some technologies need a high level of deployment to ensure their usefulness among the transportation disadvantaged. Similarly, a significant population of potential users is required to merit the costs of installing the equipment.
- **SMART—For smaller systems, consider sharing software and other system resources.** Many transit agencies lack the resources necessary to deploy ITS or employ specialized personnel for system development or maintenance. Multi-agency partnerships offer a way to maximize the benefit of hardware and software procurement while minimizing costs.
- **Wheels of Wellness—Save old equipment when upgrades are made.** Spare equipment can be used as a test-bed for system changes, a training facility for new operators, and a backup system in case of main system failure.

Implementation

- **Wheels of Wellness—Draw upon in-house expertise, i.e., those who are going to use the system, to help identify system requirements when deploying complex systems.**
- **CCRTA—Plan for the unexpected in hardware and software procurement, testing, installation and maintenance.** Set the project

schedule and budget to allow for software refinement and equipment failure during the testing, installation, and maintenance phases, as well as for equipment to become outdated in a relatively short period of time.

- **VCTC—When adding new technology that requires installation of additional devices within the bus, carefully consider device placement to ensure durability of the connection and accessibility by both customers and drivers.** With fare boxes, smart card readers, passenger counters, MDTs, and various other devices, the driver's area can become crowded. In addition, new buses have softer, more rounded dashes making it more difficult to attach instrumentation.

Evaluation

- **CCRTA—Be patient about system benefits.** Many benefits are not apparent at the outset but accrue over time. In addition, the benefits of the system as a whole are greater than the sum of benefits of individual components.
- **VCTC—Measure benefits using different types of metrics, and include technical, customer service, and political perspectives.** The vehicle tracking and information dissemination functions have been very successful in terms of improving customer service, and the agency has experienced political benefits as a result. The smart card fare payment system has been successful in improving customer service, however, it has not translated into political benefits for VCTC because of its association with the agency's less successful passenger counting system. VCTC staff are confident, however, that the political benefit of the smart card system will materialize with increased use of the system.
- **TriMet—Maintain a well-organized database.** TriMet's database includes photographs and lists of amenities at transit stops, ramp and lift deployments, and passenger counts. The database makes it easier to evaluate which stops and routes need alterations to solve a particular problem with accessibility.
- **All sites—Hold regular meetings with all stakeholders to help identify areas that need improvement.**

Conclusions

A wide range of ITS technologies, which can help transit agencies better serve the transportation disadvantaged, are currently deployed in the real world. While technology is constantly evolving, many of these technologies have matured into fully functioning systems that are proving their value within transit agencies and are serving clients on a daily basis.

With the high degree of variability among transit providers and the areas they serve, there is no single technology or configuration that will be appropriate for all areas. Fortunately, with the breadth of technologies that are currently available and the degree to which technology can be customized, an ITS application can be developed for almost any setting.

The deployment of ITS technology will inevitably require overcoming some hurdles, either technical or institutional. By examining what others have learned, many valuable insights can be gained and many challenges overcome. While the technologies covered in this report are focused on improving services for the transportation disadvantaged, it should also be recognized that many of these technologies are of equal benefit to the transportation providers by providing the data needed for accurate reporting and streamlining operations.

Resources

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Vendors and Developers of Software and Systems

Technology	Sites and Vendors
Passenger-related technologies	
Audible enunciators	• TriMet fixed-route buses: Orbital Sciences' Transportation Management System (TMS) • TriMet on street: custom-built system using text to voice • Flint MTA fixed-route: Luminator and Vultron
RIAS	• MUNI: Talking Signs
Braille displays of transit information	• TriMet: BrailleNote
Real-time bus location information for riders	• VCTC: NextBus • CCRTA ETA system: custom-built prediction software; user interface on top of Caliper Corporation's Maptitude for the Web and Microsoft's Structured Query Language (SQL) Server and Internet Server • TriMet fixed route (bus and rail): Transit Tracker (custom-built system using actual and historical data)
Electronic fare collection	• VCTC: ERG Transit System • CCRTA Tourist Pass: VISA standard mag strip card with custom-built back office database for user-side subsidy • Flint MTA: GFI Genfare's bus fare collection system • CRRAFT has plans to use ICTransit
Travel planner	• CCRTA transit travel planner: custom-built system using Caliper Corporation's Maptitude for the Web • VCTC: Transtar • TriMet Trip Planner: Mantech and custom-built
Organization-related technologies	
MDT or MDC	• CCRTA and Wheels of Wellness: Mentor Engineering Inc. (functionality can include GPS, smart card reader, and security features) • TriMet: Orbital Sciences TMS • VCTC: NextBus system package • OMNILink: GreyHawk Technologies, Inc.
Routing, scheduling, and billing	• Wheels of Wellness routing and scheduling, TriMet paratransit (LIFT), Flint MTA, and SMART: Trapeze • Wheels of Wellness billing: SigTrans • OmniLink: Trapeze-FLEX • CCRTA: custom-built system • TriMet Ride Connect (Portland regional option): RouteMatch • TriMet fixed-route: Giro-Hastus • TriMet Medical Transportation Program: custom-built system • Wheels of Wellness: SigTrans (financial reimbursement system) • CRRAFT: custom-built system

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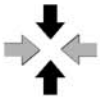
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"All this adds to our ability to deliver a quality service at a time when funding is flat and adding employees is not an option."

—Dan Marchand,
TriMet Transportation Planning Department

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