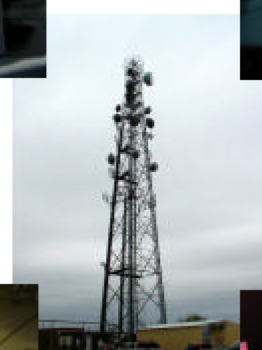
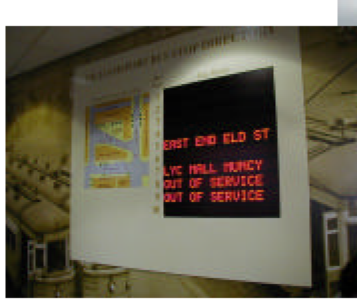
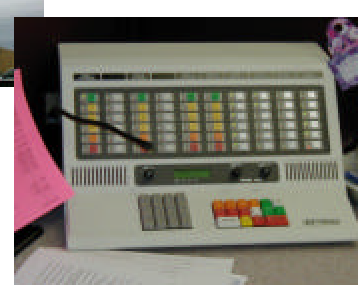
March 2003
Final Report

Rural Transit ITS Best Practices







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Technical Report Documentation Page

1. Report No. FHWA –OP- 03-77	2. Government Accession No.	3. Recipient's Catalog No.
4. Title and Subtitle Rural Transit ITS Best Practices		5. Report Date March 2003
		6. Performing Organization Code HOP
7. Author(s) Joana Conklin (Multisystems, Inc.), Carol Schweiger (Multisystems, Inc.), Buck Marks[1], with assistance from Yehuda Gross (FHWA), William Wiggins (FTA) and Karen Timpone (SAIC)		8. Performing Organization Report No.
9. Performing Organization Name and Address SAIC 8301 Greensboro Drive, M/S E-7-6 McLean, VA 22102		10. Work Unit No. (TRAIS)
		11. Contract or Grant No. DTFH61-98-C-00073
12. Sponsoring Agency Name and Address US Department of Transportation ITS Joint Program Office (JPO) 400 7th Street, S.W. (HOIT) Washington, DC 20590		13. Type of Report and Period Covered Best Practices Report January 2002 – March 2003
		14. Sponsoring Agency Code FHWA

15. Supplementary Notes
1. Formerly of Multisystems, Inc.

16. Abstract
The overall objective of this Best Practices in Rural Transit ITS project was to identify operational best practices and related technology for applying ITS to rural transit. The project team assembled information gathered through case studies to produce the Best Practices recommendations. On-site case studies were performed at the following rural transit agencies:

- The Capital Area Rural Transportation System (CARTS) in Austin, TX;
- St. Johns County, Marion County, and Putnam County, FL [part of the statewide ITS demonstration project being conducted by the Florida Commission for the Transportation Disadvantaged (CTD)];
- The Public Transportation Programs Bureau (PTPB), a division of the New Mexico State Highway and Transportation Department. The application in New Mexico is being developed by the Alliance for Transportation Research Institute (ATRI) at the University of New Mexico;
- Ottumwa Transit Authority (OTA) in Ottumwa, IA; and
- River Valley Transit in Williamsport, PA.

The on-site visits consisted of conducting interviews with staff from different levels of the agency, including operations, management, and maintenance staff. The ITS technologies were then catalogued and the case study results were synthesized into a number of considerations. Considerations were developed in the following areas: (1) use of ITS at rural transit agencies, (2) institutional and organizational issues, (3) ITS applications and technology, (4) funding and other financial considerations, (5) rural ITS project benefits, and (6) deployment process. These recommendations are presented as guidance for other agencies considering the implementation of Rural ITS solutions.

17. Key Word Intelligent Transportation Systems (ITS), Advanced Public Transportation Systems (APTS), Rural ITS, Advanced Rural Transportation Systems (ARTS), Transit ITS, Advanced Technology Transit Applications	18. Distribution Statement		
19. Security Classif. (of this report) Unclassified	20. Security Classif. (of this page) Unclassified	21. No. of Pages 168	22. Price

Form DOT F 1700.7 (8-72) Reproduction of completed page authorized

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This document is currently undergoing the section 508 review process

Acknowledgements

The research for this report was performed for the Intelligent Transportation Systems (ITS) Joint Program Office (JPO) and the Federal Transit Administration (FTA) by Multisystems, Inc. with assistance from the KFH Group, under contract to Science Applications International Corporation (SAIC). Multisystems served as the primary contractor for the study.

Carol Schweiger of Multisystems was the Principal-in-Charge of the study, and was responsible for the overall supervision of the research and preparation of the report. Joana Conklin of Multisystems and Sue Knapp of the KFH Group are the primary authors of the report. Buck Marks, formerly of Multisystems, and Ken Hosen and Sue Knapp of KFH performed most of the site visits and interviews during the research stage of the project.

The project team would also like to acknowledge and thank the following individuals for their participation in the project:

- Capital Area Rural Transportation System (CARTS): Dave Marsh, Adrian Elliott, Pearl Jackson, and Rene Guajardo.
- Lower Colorado River Authority (LCRA): James Parker
- Florida Commission for the Transportation Disadvantaged (CTD): Mary Constiner Freeman
- ARC Transit, Pasadena, FL: Boyd Thompson
- Marion County Senior Services: Gail Cross and Donna Cart.
- St. Johns County Council on Aging: Brian Nourse and Christy Sandy.
- Alliance for Transportation Research Institute (ATRI), University of New Mexico: Judith Espinosa, Matthew Baca, Nancy Bennett, and Mary White.
- Village of Los Lunas, NM: Pearl Lucero and Shereen Snare.
- Zuni Entrepreneurial Enterprises: Larry Alflen
- TransCom: Jack Valencia
- Ottumwa Transit Authority (OTA): Pam Ward
- River Valley Transit**:** William Nichols, John Kiehl, Kevin Kilpatrick, Dennis Hahn, and Rob Lentz.

The guidance of Mike Freitas and Yehuda Gross, from the ITS JPO, and William Wiggins, from the FTA, is also acknowledged, as well as the comments received from Karen Timpone, Mark Howard, and David Register at SAIC.

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Glossary of Terms and Acronyms

Advanced Public Transportation System (APTS) - Advanced technology system that improves public transportation operations, management, planning, communications and other aspects of public transportation service.

Advanced Traveler Information System (ATIS) - Advanced technology system that collects, processes and/or disseminates information about the surface transportation system. ATIS can provide information pre-trip and en-route through a variety of media, including telephones, personal computers, the Internet, variable message signs, in-vehicle devices, kiosks, monitors, etc.

Advanced Transportation Management System (ATMS) - ATMS employs advanced technologies to provide transportation information and/or to manage and control transportation networks.

Americans with Disabilities Act (ADA) - 1991 Act that contains provisions on the acquisition of accessible vehicles by public and private entities, requirements for complementary paratransit service by public entities operating a fixed route system, and provision of nondiscriminatory accessible transportation service.

Analog - The transmission of data as electronic signals of varying frequency or amplitude.

Automatic Passenger County (APC) - An automated means for collecting data on passenger boardings and alightings by time and location.

Automatic Vehicle Identification (AVI) - A system that provides vehicle identification information, including such technologies as electronic vehicle tags and tag-reading devices.

Automatic Vehicle Location (AVL) - A system that senses, at intervals, the real-time location of transit vehicles carrying special electronic equipment that communicates a signal back to a central control facility, locating the vehicle and providing other information about its operations or about its mechanical condition.

Brokerage - An organizational structure wherein an agency contracts with an operator to provide all services necessary for transit service delivery, including reservations and scheduling, securing reimbursement payments from clients, and transit operations. In this case, the agency provides limited administrative support, oversight of the contract operators and policy direction, and funding.

Cellular - Communications systems that divide a geographic region into sections, called cells. The purpose of this division is to optimize the use of a limited number of transmission frequencies. Each connection, or conversation, requires its own dedicated frequency.

Cellular Digital Packet Data (CDPD) - A fast, efficient digital system that overlays the existing cellular network. It allows a mobile user to send and receive data from other data networks, such as e-mail applications or a central computer.

Communications Interoperability - The ability for two or more parties (e.g., two different agencies) to exchange information, when and where needed, even when disparate communications systems are involved.

Computer-Aided Dispatching (CAD) - Software that helps the dispatcher identify and assess the feasible alternatives when operational problems occur, and which keeps a comprehensive record of any changes that are made. Although CAD can operate using voice communications, MDT (Mobile Data Terminal) text messaging is often used to facilitate these processes.

Dedicated Short-Range Communication (DSRC) - Communication that takes place at a special frequency, and usually consists of a transponder (or tag) that communicates with a beacon (or tag reader). The beacon may communicate with another device or control center to transmit the data it received from the transponder.

Demand Response Service - A method of transit service delivery wherein vehicles, schedules, and routes change daily based on trip requests from transit users.

Digital - Electronic technology that generates, stores, and processes data in terms of two states: positive and non-positive. Positive is expressed or represented by the number 1 and non-positive by the number 0. Prior to digital technology, electronic transmission was limited to analog technology, which conveys data as electronic signals of varying frequency or amplitude that are added to carrier waves of a given frequency.

Electronic Fare Payment System - Machine-readable farecards used to carry fare payment or rider identification information. Applications can provide fixed data such as a rider identification number or updateable data such as the end date for a period pass, the remaining number of prepaid rides, or the remaining prepaid cash fares balance. Fare payment systems can be used as part of an automated invoicing system.

Fixed Route Service - Transit service provided on a repetitive, fixed-schedule basis along a specific route, with vehicles stopping to pick up and deliver passengers to specific locations.

Fleet Management System - Software that provides the ability to track vehicles and their repair and maintenance requirements. Common features include the ability to track repairs and mileage and to generate report information based on vehicle type, manufacturer, and model.

Geographic Information Systems (GIS) - A computer system capable of assembling, storing, manipulating, and displaying geographically referenced information (i.e., data identified according to its location).

Global Positioning System (GPS) - The GPS is a "constellation" of well-spaced satellites that orbit the Earth and make it possible for people with ground receivers to pinpoint their geographic location. The location accuracy is anywhere from 100 to 10 meters for most equipment. The GPS is owned and operated by the U.S. Department of Defense but is available for general use around the world.

Intelligent Transportation System (ITS) - Electronics, communications, or information processing used singly or in combination to improve the efficiency or safety of a surface transportation system.

Mobile Data Terminals (MDT) - Small special purpose computers mounted near the driver, with a small keypad and display to provide an interface with a mobile data communication system. MDTs support text messaging between drivers and dispatch which can help improve efficiency by transmitting the trip manifest for the run directly to the vehicles, as well as any real-time manifest changes during daily operations. MDTs can enable further enhancements to daily operations through computer-aided dispatch (CAD) and automatic vehicle location (AVL) software.

Paratransit - The term paratransit will be used in a general sense in this report to refer to a broad range of transit service types that have neither fixed-route nor a fixed schedule.

Point of Presence (POP) - An access point to the Internet.

Radio Frequency (RF) - A frequency range within the electromagnetic spectrum associated with radio wave propagation. When an RF current is supplied to an antenna, an electromagnetic field is created that then is able to propagate through space. Many wireless technologies are based on RF field propagation.

Real Time - Data that is displayed and/or used at the same time it is collected.

Scheduling Software - See Transit Operations Software.

Subscription Service - A method of transit service delivery that requires users to "subscribe" to the service. The service patterns are relatively stable and repetitive, based on the standing orders from users.

Technology Profile Levels (TPL) - Developed to group rural and small urban transit agencies by some common features. These TPLs will eventually set-up the task of developing a common migration strategy for developing and implementing technology statewide.

Transit Communications Interface Profiles (TCIP) - A suite of data definition/interface standards for the transit industry. The TCIP standards define all the information used by transit agency systems with standard names and formats.

Transit Operations Software - Also referred to as scheduling software. A software package that typically includes GIS, reservations and scheduling software, CAD (Computer-Aided Dispatch) and report writing features (for reimbursements). Lower-end packages may have more limited capabilities.

Transit Technology Profile (TTP) - A categorization system used to group the state's 23 rural and small urban transit agencies based on needs and factors such as size and scope of operations, complexity of service delivery, and degree of service coordination.

Transportation Management Center (TMC) - Employs advanced technologies to provide transportation information and/or to manage and control transportation networks.

World Wide Web (WWW) - Internet vehicle that provides text and graphics on specific "pages" (e.g., a set of text and graphics on a particular subject). A WWW browser is an application program that provides the user with the ability to easily browse through a variety of types and sources of information.

Section 1 Executive Summary

The overall objective of the Best Practices in Rural Transit ITS project was to identify operational best practices and related technologies for applying ITS to rural transit. The project team assembled information gathered through case studies (supplemented by a literature review) to produce the Best Practices recommendations. On-site case studies were performed at the following rural transit agencies:

- The Capital Area Rural Transportation System (CARTS) in Austin, TX;
- St. Johns County, Marion County, and Putnam County, FL [part of the statewide ITS demonstration project being conducted by the Florida Commission for the Transportation Disadvantaged (CTD)];
- The Public Transportation Programs Bureau (PTPB), a division of the New Mexico State Highway and Transportation Department. The application in New Mexico is being developed by the Alliance for Transportation Research Institute (ATRI) at the University of New Mexico;
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- River Valley Transit in Williamsport, PA.

The on-site visits consisted of conducting interviews with staff from different levels of the agency, including operations, management, and maintenance staff. The ITS technologies were then catalogued, and the case study results were synthesized into a number of considerations. These recommendations are presented as guidance for other agencies considering the implementation of rural transit ITS solutions. Section 8 includes considerations that were developed in the following areas:

- Use of ITS at rural transit agencies;
- Institutional and organizational issues;
- ITS applications and technology;
- Funding and other financial considerations;
- Rural transit ITS project benefits; and
- Deployment process considerations.

The use of ITS at rural transit agencies varies depending upon the agency's need and the available resources and is described in Section 8.1. A number of different types of technology have been deployed, including communication systems, scheduling and dispatching software, automatic vehicle location (AVL)/mobile data terminal (MDT) systems, traveler information systems, and electronic fare systems. In some cases, agencies have installed and integrated multiple technologies. Most of the rural properties are using these technologies over a large service area, primarily for demand responsive transportation services. The case study participants pointed to a number of different goals for their ITS deployments, including improving customer service, increasing the efficiency of operations and administrative functions, and increasing coordination between operators. Many of the agencies also have plans to either enhance their existing technologies, increase agency participation in their ITS programs, or to deploy new technologies in the future.

Often, implementing new ITS solutions can involve a significant change in the way that everyday operations are conducted at a transit agency. These changes can be challenging for staff, and it is thus important to try and anticipate potential institutional and organizational issues that might arise. The case studies uncovered a number of such issues. Those issues that are most likely to affect other rural transit agencies undertaking ITS deployments are presented in Section 8.2.

A number of ITS applications and technology considerations also emerged from the Best Practices effort and are included in Section 8.3. These recommendations cover the realm of technologies used by the case study participants, including reservations/scheduling software, geographic information systems (GIS), and communications/radio systems. Some general considerations that span multiple types of technological solutions are also presented.

Funding for ITS projects is another key issue that rural transit agencies face. Without funding, the implementation cannot occur. The recommendations regarding funding and other financial considerations include a summary of the funding sources used by the case study participants. Section 8.4 also includes some basic recommendations regarding the use and procurement of funds for other rural transit ITS projects.

The case studies also highlighted a number of benefits that can and have emerged from rural transit ITS deployments. In Section 8.5, overall project benefits are first presented (i.e., those that are not technology specific). Then, benefits for each of the following specific technologies are outlined: (1) reservations/scheduling/dispatch software, (2) AVL/MDT systems, and (3) customer information systems. Anticipated and unexpected benefits to agency staff, customers, and other stakeholders are included in Section 8.5.

Following the description of rural transit ITS project benefits, Section 8.6 presents deployment process considerations. These recommendations are broken down into the following stages of an ITS deployment: (1) project planning, (2) procurement, (3) project installation and implementation, and (4) operations. Project planning includes all of the pre-project activities that an agency would undergo prior to installing, testing and implementing ITS. Considerations in this area include ITS needs assessment and design, among other issues. The procurement subsection includes information regarding selection of vendors, contract and specification issues, and institutional issues related to procurement. The installation and implementation subsection provides guidance regarding the phases of implementation, acceptance procedures, and problem tracking. The final subsection summarizes the operational challenges faced by the case study sites and provides insight into how agencies might avoid potential problems once their ITS systems have been put into full operation.

2.1 Scope Summary

The overall objective of the Best Practices in Rural Transit ITS project was to identify operational best practices and related technology for applying ITS to rural transit. The project team assembled information gathered through case studies and addressed any relevant findings from the Non-User Survey activity to produce its Best Practices recommendations.

Specifically, the project objectives were to:

- Identify rural transit operators that exhibit best practices for ITS User Services in operating their transit systems using ITS technology;
- Target case study sites to cover a range of rural transit services using ITS technology including, to the extent possible, fixed route, flexible routes and paratransit services;
- Report functional and limited technical information on the technologies and applications that the case study sites have applied to their rural transit services;
- Report on the lessons learned by the case study participants; and
- Summarize overall considerations for the application of ITS to rural transit learned from the case studies.

The project scope included the following activities:

- The project team performed background research to identify candidate case studies. The research involved reviewing previous studies and literature, FTA information on rural transit funding, and the project team's extensive contacts and experience in this area.
- Five on-site case studies were performed. Each case study involved two researchers and a site visit scheduled to last up to three days. The on-site visits consisted of conducting interviews with staff from different levels of the agency, including operations, management and maintenance staff.
- The project team catalogued ITS technologies observed during the case studies and obtained additional information, where needed, to support an understanding of these systems.
- The case study results, as well as lessons learned and overall considerations, were synthesized into a final report that can be used as a resource by other agencies considering the implementation of Rural ITS solutions.

The process of identifying and selecting the case study participants, as well as more detail on the site visits themselves, are included in the following subsections.

2.2 Identification of Potential Rural Transit ITS Projects

2.2.1 Sources for Identifying Case Study Sites

Prior to conducting the case studies, the research team performed a literature review to help guide the research process. The primary objectives of this task were to:

- Identify important issues in applying ITS technology at rural transit agencies;
- Identify potential agencies to include as case study sites; and
- Obtain information to structure the case study process.

The project team performed background research to identify candidate case studies. In addition to reviewing a variety of conference proceedings (including the World Congress on ITS and ITS America Annual Meetings), sources were selected from the following:

- The USDOT ITS Joint Program Office (JPO) and its electronic document library (EDL);
- The Transportation Research Board (TRB) and its Transportation Research Information Services (TRIS) database;
- Partners for Advanced Transit and Highways (PATH), a joint effort of Caltrans and University of California at Berkeley;
- The Community Transportation Association of America (CTAA);
- The ITS Cooperative Deployment Network (ICDN);
- The Institute for Transportation Research and Education (ITRE) at North Carolina State University;
- The Center for Urban Transportation Research (CUTR) at the University of South Florida; and
- The Western Transportation Institute (WTI) at Montana State University.

Over 25 individual sources were consulted to complement the project team's contacts, experience, and previous research in this area. Appendix B provides a bibliography of source documents used in the project.

Information about rural transit ITS projects is dated in some cases. Where information is available over time, it appears that many projects have not significantly advanced their transit ITS applications. Agencies continue to face institutional and organizational barriers in moving from planning to deployment. Some of the preliminary findings that provided guidance in selecting the case study sites included:

- Many rural transit ITS deployments have been studied repeatedly, indicating that the project team should make a concerted effort to identify other programs that have not been studied or ensure that previous study sites have advanced to the point where they might qualify as Best Practices examples;

- Rural systems have a general awareness of ITS, but they depend heavily on their vendors for specific information on transit ITS applications. In many cases, transit ITS solutions have been oversold or agency expectations have been unreasonably high. This can lead to agency ITS needs not being met by product vendors;
- Rural transit managers need case study experiences and peer contacts to help guide them in acquiring and deploying ITS products that satisfy their needs;
- Use of outside professional expertise for activities such as developing systems specifications or providing systems integration support may be useful for rural transit agencies planning ITS procurements;
- Core or supporting ITS technologies may be different in rural areas than those deployed in urban settings. For example, geographic information systems (GIS) are an assumed component in urban ITS deployments, but they can be a significant standalone ITS deployment for rural transit agencies. Results of GIS applications have given the smaller operators new tools for improving service planning and operations, and may provide the basis for additional transit ITS deployment such as AVL/CAD and scheduling systems; and
- Training staff in the use of transit ITS products is as important, if not even more important, in small rural transit agencies as it is in much larger transit agencies.

2.2.2 Development of Criteria

The findings of the literature review were used to develop a number of criteria for selecting the case study sites. Ultimately, the team developed a list of five criteria, as described below.

Criterion 1: Case study candidates must have successfully deployed ITS projects tailored to rural transit users, and particularly to the rural market segment of interest.[1] The projects must have had enough time to mature. Maturation is defined as:

- All substantial bugs have been worked out of the system and it is operating as originally intended.
- The system has been operating long enough for the agency to determine whether it has had an impact on operations, costs, management, customer service, or ridership. While "long enough" is not very specific, it is tentatively defined as six to 12 months or more. Incremental deployment in phases will be taken into account. For example, a rural ITS project may not be completed but it may have achieved enough significant milestones that would make it an appropriate candidate.

Criterion 2: Case study candidates must exhibit best practices in the deployment, operation, or integration of their ITS technology. Best practices are primarily defined as the use or application of technology to improve operations, performance, or customer service. Best practices related to institutional or organizational challenges are not the focus of the case studies, although they will be noted

[1] The seven rural market segments, as defined by the FTA, are: Rural-to-Metropolitan Area Communities; Large, Sparsely Populated Rural Areas; Rural Tourist Areas; Slow/No Growth, Self-Contained Local Communities; High Growth, Self-Contained Local Communities; Small, Poor, Growing Communities; and Small, Poor, Declining Communities.

as supporting elements. Generally, then, best practices would exhibit some combination of the following characteristics:

- The system, its components, or its use/application represents an innovative application of ITS technology.
- The system, its components, or its use/application represents the only known transit application of its kind and is judged by the project team to hold promise for further development either within the case study agency or at other rural transit agencies.
- The operator has maximized the benefits resulting from the system, its components, or its use/application.
- The system has been successfully integrated with other technologies.
- The deployment has been successful from an operational, cost, management, customer service, or ridership perspective. However, the system, its components, or its use/application may not necessarily be successful from all of these perspectives, which would still be useful information in the best practice analysis.

Criterion 3: Case study candidates should be distributed, to the extent possible, among the seven rural ITS market segments. Ideally, the case studies would involve agencies that have not previously been studied in depth using the methodology used for this study. However, agencies that have been the target of earlier case studies could be included if they have experienced substantial progress and have thus become examples of best practices.

Criterion 4: The full set of case study sites should be representative of different rural transit service types. This means that fixed route, flexible routes, and demand-response services should be covered. Some preference will be given to agencies that provide all service types or at least two of them.

Criterion 5: Case study candidates must agree to participate in the preparation for the case study visit, on-site activities, and follow-up phases of the research. This will include responding to information requests, provision of background documents or data, and helping to identify and make the necessary staff available during all phases of the case study process.

2.3 Selection of Rural Transit ITS Projects

Once the project team began the literature review and the search for case study sites, the team realized that locating rural transit ITS projects that met the selection criteria listed above was going to be a challenge. Specifically, the following criteria seemed to be the most difficult to meet:

- Select sites that have had limited involvement in previous related studies;

- Select sites that have had operating experience with transit ITS technologies (allowing a focus on operational best practices);
- Select sites that display unique uses or applications of technology;
- Select sites where all of the significant operational and technological issues had been worked out; and
- Select sites where the system has been successfully integrated with other technologies.

The project team found that very few rural properties had actually moved from the ITS planning stage to procurement and implementation. Therefore, the sites that had moved forward generally had been included in some sort of previous research. Likewise, it was difficult to find sites that had actual operational experience with transit ITS technologies. Nonetheless, the project team was able to select five case study sites. These sites are summarized below.

River Valley Transit: Located in Williamsport, PA, the agency provides real-time customer information at its transit center. River Valley Transit installed automatic vehicle location (AVL) and mobile data terminals (MDT) on its fixed-route buses to provide real-time, in-terminal customer information. The technology allows the agency to inform customers both visually and audibly as to which of the 10 loading bays buses will arrive at and depart from. It also gives customers a 20-second notification before buses depart on their next trip. The system even notifies drivers when they have pulled into the wrong bus bay. River Valley Transit is looking at ways to extend the utility of the system and has investigated other ITS technologies.

Florida Commission for the Transportation Disadvantaged (CTD): Through the CTD, a number of primarily rural counties have created low-cost ITS applications using seed funding from the FTA. The deployments are part of a statewide Rural ITS initiative. The project has been implemented in two phases. In addition to information from the CTD, the case study also includes information gathered during site visits at two of the Phase I counties (St. Johns and Putnam), and one of the Phase II counties (Marion). Marion and St. Johns counties have been using a demand-response software suite developed by RouteLogic. The software has a range of modules including vehicle scheduling, staff scheduling, trip scheduling, call-intake, and payroll. As of February 2002, the system had been in place for over a year in these two counties. It has turned the operation in St. Johns County from a struggling service to a thriving, cost-effective one. Putnam County, by contrast, has opted to use a proprietary software system it had developed and integrated with AVL. The RouteLogic application is being used as the model to improve the operations and management of other rural transit operators in the state.

Capital Area Rural Transit System (CARTS): Providing rural transit service in a large area outside of Austin, Texas, CARTS is a partner in the Lower Colorado River Authority's (LCRA) communications system. The system provides CARTS with voice channels on LCRA's 900MHz radio system, which replaced the patchwork of unreliable radio links CARTS used previously. This new communication system has allowed CARTS to reorganize and more efficiently provide its paratransit service. CARTS's agreement with LCRA was negotiated to provide enough communication capacity in the future so that CARTS could add AVL/MDT or other ITS technologies. The agency has started work on deploying AVL/MDT technology.

Ottumwa Transit Authority (OTA): OTA is responsible for providing bus service in Ottumwa, Iowa and the surrounding 10-county area covering 5,000 square miles. After attempting to share resources with nearby Linn County, OTA installed a four-tower, 150 MHz radio system to provide communications for its AVL/MDT system throughout its large service area. At the time of the site visit, the package had been in place for about 18 months. One unique feature of OTA's system is a form-based MDT log-on/pre-trip procedure that requires drivers to transmit information to central dispatch regarding the mechanical condition of a vehicle. This feature is especially useful for the approximately 40 vehicles that are garaged at drivers' homes, some of which are over 50 miles away from OTA headquarters. The OTA uses the pre-trip information to determine if maintenance should be scheduled at the agency's central garage or could be repaired by one of its subcontracted, out-of-county mechanics.

New Mexico Statewide Rural Internet-Based Ridership and Financial Tracking System: Led by the Alliance for Transportation Research Institute (ATRI), this project is an interagency effort that includes the NM Human Services Department Income Support Division and rural transit service providers. The project was chosen because it is a statewide, multifunctional, Web-based application that has a number of unique features.

The project is being deployed in three parts. During part one, ATRI developed a Web-based software program to authorize and schedule trips, track riders, bill trips, and generate reports. The Web-based application is designed to save costs of and the time required to install, troubleshoot, and upgrade the software by having a single application reside on a Web server that is accessible to users over the Internet. Part two involves establishing the Internet connections between the central server and the rural agencies so they can report trips and expenditures to a central server. This phase will be completed in October 2002. Part three of the project currently is procuring a multipurpose electronic farecard system and card readers for transit vehicles and integrating them with the software system. The system will use the state's electronic benefits transfer (EBT) card to track transportation benefits for clients. General public riders will also be able to buy disposable, magnetic stripe passes that can be used on transit vehicles.

2.4 Planning and Design of Case Study Site Visits and Interviews

Once the sites were selected and approved by the FTA and ITS JPO, the project team obtained commitments to participate, and scheduled on-site interviews. For each case study location, the team summarized current transit services and usage, existing ITS technologies and applications, and demographic information prior to performing on-site interviews. During this time, the research team also finalized the case study research approach, which included developing a consistent case study format. In order to ensure consistency, the team developed an interview guide, which is included in Appendix C. The primary topic areas included in the interview guide were:

- System/Project Overview;
- Stakeholders;
- Project Goals and Objectives;
- Description of the System and Technology;

- Summary of Costs;
- Operations and Performance;
- Lessons Learned; and
- Future Plans

Case study participants were provided with an abbreviated copy of the interview guide prior to the on-site visit. Site visits were conducted between January and April 2002. In addition to face-to-face interviews, the researchers obtained additional technical information and documentation as needed during the site visits. Additionally, follow-up was conducted with participants as the case study information was being synthesized into this report.

2.5 Organization of the Report

The remainder of this report consists of six sections. Sections 3 through 7 comprise the detailed case study descriptions. Each case study is organized into the following sections:

- Case Study Overview;
- Project/System Background and History;
- Project Goals and Objectives;
- Description of the Application and Technology;
- Design, Operations, and Performance;
- Project Costs and Revenue Sources;
- Considerations/Best Practices; and
- Future Plans.

Section 8 concludes the report with a discussion of overall operational considerations derived from the case studies in the area of Rural Transit ITS.

3.1 Case Study Overview

The Capital Area Rural Transportation System's (CARTS's) rural transit ITS project was selected as one of the Rural ITS case studies because it uses a sophisticated, 900 MHz two-way radio system combined with automated demand responsive transportation scheduling software. CARTS leases airtime on the Lower Colorado River Authority's (LCRA's) state-of-the art radio system.[2] Installation of CARTS's radio system began in 1998, when a contract was signed with the LCRA, and the system was fully operational by 2000. The paratransit scheduling and dispatch software, Trapeze's PASS, was purchased prior to implementation of the radio system, and was recently upgraded from DOS to a Windows version. This combination of state-of-the-art technology has enabled CARTS to centralize reservations, scheduling, dispatching, and operations of its demand-response services. The radio system and DRT software will also serve as the foundation for the installation of an AVL/MDT system during 2002.

CARTS's continuing goal for deploying ITS technologies is to increase and improve customer service for its riders. The CARTS transit ITS project clearly demonstrates how paratransit software, a well staffed and equipped dispatch center, and a good wireless communications network can be successfully integrated in a rural transit system.

3.1.1 CARTS Transit System Overview

CARTS is responsible for serving nine predominantly rural counties in the greater Austin, Texas region. The CARTS service area encompasses 123 communities and over 7,500 square miles. CARTS provides:

- Fixed-route transit in three municipalities;
- A network of inter-county services, with connections to inter-city bus service;
- Commuter service from park & ride lots in two communities to downtown Austin;
- Fixed schedule or demand responsive transit to thousands of general public customers in Central Texas; and
- A variety of services for human service customers.

The system has a fleet of 75 vehicles, which carry an average of 1,200 one-way daily trips. Of these, about 75% are demand responsive paratransit trips. Due to the large service area and different transit needs served by CARTS, the agency needed to develop services that would be tailored to each locale.

[2] LCRA plays a variety of roles in Central Texas: delivering electricity, managing the water supply and environment of the lower Colorado River basin, developing water and wastewater utilities, providing public recreation areas, and supporting community and economic development (LCRA Web site: http://www.lcra.org/about/index.html).

In other words, a community could receive service throughout the day, once a day, or once a month, and the ITS system was required to deal with that.

CARTS has four intermodal transit facilities to enable the coordination of services among fixed-route, commuter vans, inter-city, intra-county, and demand-response services. The system is also the intercity bus agent (Greyhound and Kerrville bus companies) in four communities, and has an Amtrak stop at its intermodal facility in San Marcos.

The CARTS dispatch center includes five reservationists, two dispatchers, one scheduler, three supervisors, and a number of managers. With the centralization of staff and facilities enabled by the radio system and software, staff regularly share their duties with one another. The dispatch center was designed to promote the efficient flow of information and to allow the staff to concentrate on their jobs in a quiet and comfortable manner.

3.1.2 CARTS Case Study Field Work

The research team conducted a site visit at CARTS on April 3 and 4, 2002. The visit was coordinated by CARTS's Executive Director, David Marsh. In addition to participating in interviews and providing background materials when the team was on-site, Mr. Marsh organized meetings with:

- Pearl Jackson, Director of Operations;
- Adrian Elliot, Special Projects Coordinator; and
- Rene Guajardo, Director of Safety and Service Quality.

To obtain a more realistic sense of how the ITS system worked, the research team observed and interviewed CARTS call takers, schedulers, and dispatchers while they used the system. The research team visited LCRA's Telecommunications Operations Center (TOC) and spoke with James Parker, Manager, and his staff about the service they provide to CARTS. Also, they provided information on their plan to ensure sufficient bandwidth for the AVL/MDT installation.

3.2 Project/System Background and History

Before CARTS signed an agreement to use the LCRA's state-of-the-art radio system, the transit agency operated with a radio infrastructure that did not adequately cover its large geographic service area. This set-up created significant operational, customer service, and cost problems. At times, CARTS contracted with up to six commercial mobile radio service providers to create a patchwork wireless communications network. Although some of the system components were linked together, radio communications were unreliable and consumed a disproportionate amount of staff time to work around their limitations. The overall impact of this patchwork system was that it prevented the agency from realizing many of its goals, most notably, improved customer service.

The old radio system created a host of management problems that detracted from CARTS's mission. Perhaps the most significant problem was that the previous radio network forced the agency to maintain three separate reservation, scheduling, and communications centers, distributed throughout its service area. Although some communications subsystems could be linked together technologically to provide voice transmission across the area, numerous coverage gaps made the system more unreliable. At times, CARTS was forced to use up to 13 remote transmission towers, making communications prone to frequent service disruptions. This situation prevented CARTS from taking full advantage of its demand responsive paratransit service.

Around 1990, CARTS's Executive Director, David Marsh, learned that LCRA was planning to purchase and install an advanced radio communications system. Believing that participation in the new system might help CARTS with some of its operational challenges, Mr. Marsh tracked the development of LCRA's radio plan. In 1993, CARTS performed a needs assessment to determine the priorities and timing of its ITS deployment. In 1996, the agency established an agreement with LCRA to become its first customer. A contract for radio service was signed with LCRA in 1998, at which time installation began. CARTS's radio system became fully operational in 2000.

While CARTS was working with LCRA to attain service on the new radio system, the agency procured its paratransit scheduling and dispatch software from Trapeze in 1994. CARTS secured the services of an independent consultant to help write the specifications for and procure the new software. In 1999, CARTS upgraded from Trapeze's DOS-based version of their PASS software to the Windows version of the product. In 2000, CARTS closed its three remote scheduling and dispatch offices and combined all scheduling, dispatch, and operations in its main offices.

The radio system upgrade allowed CARTS to centralize reservations, scheduling, and dispatch within one facility.

The next step was the development of a dispatch center that was conducive to dispatchers' concentration and the efficient flow of work. CARTS moved into its headquarters in 1993 and shortly thereafter designed a dispatch center. This dispatch center includes a reservation area and separate dispatch/supervisor office. Vehicle operators are not permitted to roam about the dispatch center, so as not to distract the schedulers and dispatchers.

CARTS began the procurement process for an AVL/MDT system in 2000, hiring an independent consultant to develop specifications for the system, assist with the procurement process, and help oversee system deployment. CARTS released a Request for Proposals in 2001 and subsequently signed a contract with a team headed by Mentor in 2002. The agency expects to have installation completed and, at least, parts of the AVL/MDT system operating by the end of 2002. Simultaneously, Trapeze will add its AVL/CAD module to the paratransit scheduling software. CARTS expects to have pilot testing of the AVL/MDT system started during the summer of 2002 and full pilot implementation (for 10 vehicles) completed by the end of 2002. Eventually, all of CARTS's demand response vehicles will be equipped with the AVL/MDT system.

3.3 Project Goals and Objectives

Even before CARTS began implementing components of its transit ITS system, its main goals were to improve customer service and expand the availability of service. These goals guided the agency in planning and executing its ITS deployment strategy. While CARTS certainly had specific objectives for deploying each component, such as staff acceptance and expandability, those are secondary to improving customer service.

3.3.1 Stakeholders

Unlike some of the other case studies in this report, specific stakeholders do not stand out in terms of guiding CARTS's transit ITS deployment. If anything, its existing and future customers were the primary stakeholder group because of the agency's customer service goals. Nevertheless, there have been other stakeholders who have had input into CARTS's plans. The district office of the Texas Department of Transportation (TxDOT) has been involved at various stages. The FTA is also a stakeholder given that Section 5311 funds have been used to procure some of the ITS components.[3] Communities in the CARTS service area have been consulted as well. Finally, there are inherently a number of internal stakeholders, including dispatchers and schedulers.

Although LCRA is a communication service provider, the agency has also been a stakeholder. Given that CARTS was its first customer to sign up for radio services, LCRA had an interest in ensuring that the CARTS installation and operation was a success. LCRA hoped that its deployment at CARTS would show other public service agencies the potential of establishing agreements for radio services. CARTS remains the largest of LCRA's 31 customers in terms of bandwidth usage. Therefore, LCRA is required to participate in CARTS's ITS planning process to ensure that sufficient bandwidth is maintained as the AVL/MDT system is deployed. LCRA also played a central role in designing an open talk group so that CARTS and public service agencies could communicate effectively in the event of an emergency.

3.3.2 Goals and Objectives

While CARTS's overreaching goals for their ITS deployments have been to improve customer service and expand the availability of service, the research team identified several specific objectives that CARTS has pursued in the process of deploying its ITS components. Some objectives have been achieved through one or more of the three ITS components CARTS has deployed. The objectives include:

- Develop one uniform service approach throughout the agency's service area, ensuring that all customers receive the same quality of service;
- Plan, procure, and implement one ITS component at a time, working out all the bugs before proceeding to the next phase;
- Obtain seamless and reliable radio communications, which will improve both customers' and drivers' sense of security, especially in remote parts of the CARTS service area;
- Centralize and integrate operations by consolidating the three remote scheduling and dispatch centers into a single well designed facility;

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[3] The FTA's Section 5311 funds capital, administrative, and operating expenses incurred in the provision of rural public transportation.

- Establish a single, toll-free customer service telephone number throughout the entire service area;
- Manage clients, reservations, and scheduling more effectively and enhance dispatching to improve operations;
- Improve record-keeping information for clients and for reporting purposes;
- Better enable connections between paratransit service providers and to fixed route services where possible;
- Create more trip capacity and provide a means for scheduling more same-day trips; and
- Enable the system to expand geographically as more communities request services.

3.4 Description of the Application and Technology

3.4.1 General System Characteristics

Although the primary focus of the CARTS rural transit ITS case study relates to the radio communications network, the agency's demand-response paratransit software and imminent installation of an AVL/MDT system are essential for understanding the full extent of the ongoing ITS project. All three elements are summarized below.

Community Link Radio System

As described previously, CARTS initially had a problematic patchwork radio system that prevented the agency from taking full advantage of its demand responsive paratransit service. CARTS now leases airtime on the LCRA's state-of-the-art radio system. CARTS also purchases a variety of support services from LCRA, including:

- Installation of the original radios for CARTS, provision of technical support and training, and modifications to the radios;
- Provision of radio dispatching from its TOC when CARTS does not staff its own dispatch center; and
- Repairs on CARTS's fixed facility and mobile radio equipment.

CARTS's agreement with LCRA includes dispatching during off-hours from LCRA's state-of-the-art dispatch facility.

Because LCRA's fixed facility radio network is much larger than CARTS's service area, CARTS is able to rely on this single network and experiences almost no coverage gaps. Since LCRA uses the radio network for its own communications purposes, it maintains the system and fixes any problems quickly so that few service disruptions occur. The reliability and other elements of the radio system design ensure that CARTS drivers and dispatchers are able to communicate with each other quickly at all times. The LCRA radio system will provide the necessary bandwidth for CARTS's forthcoming AVL/MDT system.

To become part of the LCRA radio network, CARTS had its existing radios replaced with new units that were compatible with the LCRA communication protocols. At one time or another, CARTS uses most of LCRA's 40 radio towers. The digital LCRA system will allow CARTS to communicate vehicle tracking information and use MDTs for text messaging when those components are deployed, which will help reduce the need for and amount of voice traffic. LCRA also sells airtime to other public sector and public safety agencies such as the fire and police departments, which is beneficial because CARTS can communicate directly with public safety agencies and vice versa in the event of an emergency.

With a single radio network, CARTS has been able to combine all of its reservations, scheduling, and dispatching functions into its main offices in Austin, thus improving customer service. Centralization has allowed CARTS to create a single, toll-free reservation line, which was not feasible in the past. The centralization is a change that CARTS staff believes makes its service more marketable. The centralized operations allow the agency to use its paratransit software much more efficiently now because it can be operated on a single server instead of three. Therefore, all client information, trip making activity, and system geography is stored in a single database available to authorized administrative staff. The cost of upgrading and modifying the paratransit software and hardware has been cut to one-third its previous cost because changes are easier to perform at a single location.

Paratransit Scheduling and Dispatch Software

CARTS uses Trapeze PASS Version 4.3.1 paratransit scheduling and dispatch software for its demand responsive services. The software was purchased before the radio system became available. PASS has been upgraded from the DOS to the Windows version (in October 2000), which provides more functionality. The addition of the radio system enabled CARTS to centralize the use of PASS from its three previous installations, allowing the agency to use the software more effectively.

AVL/MDT System

Now that the radio system and paratransit software are functioning properly and providing anticipated benefits, CARTS is in the process of procuring and deploying an integrated AVL and MDT system. The agency has selected a team headed by Mentor Engineering, which has subcontracted certain parts of the project to Trapeze and LCRA. Mentor has taken on the responsibility of systems integrator and has secured written agreements with all parties. LCRA has participated in CARTS's AVL/MDT procurement process to ensure that the proposed equipment and data transmission requirements will be consistent with the radio infrastructure and capacity. CARTS required that the successful AVL/MDT vendor subcontract with LCRA to participate.

3.4.2 Technological Components

The technological components of the CARTS's radio system, reservation and dispatch software, and AVL/MDT system are described in more detail below.

Community Link Radio System

LCRA's Community Link radio system was purchased from Ericsson (now Com-Net Ericsson) and operates in the 900 MHz UHF band. The radio system is capable of transmitting analog or digitized voice and digital data. The system uses Ericsson's proprietary Enhanced Digital Access Communication System (EDACS), a form of digital trunking technology, which maximizes the efficiency of radio channels. Trunking involves a group of radio frequencies being managed by computer to optimize the capacity of each. It does so by eliminating dead time on any frequency by switching communications to the next available channel (very similar in concept to how cell phone networks operate). This is important since LCRA provides radio services to 31 customers totaling approximately 3,000 mobile radios.

LCRA's trunked system maximizes the efficiency of radio channels.

The result of using this technology is that radio users are not aware of which physical radio channel they are speaking over, only that a communication path has been established between vehicle and dispatch. Multiple users are accommodated on trunked radio systems by the creation of "talk groups," which act as 'virtual' radio channels, with the same or better privacy and security as a traditional radio frequency. One advantage of this setup is that vehicles are less likely to experience an occupied frequency and be prevented from communicating when desired.

CARTS has exclusive access to five talk groups. CARTS vehicles are assigned to talk groups based on the geographic subregion in which they operate. Dispatchers monitor assigned talk groups, making operations more efficient. The Ericsson system also allows for I-calls, transmissions that can be broadcast over all talk groups simultaneously, to an individual, or to a subgroup of drivers. This feature can be used for a variety of operational and management purposes. If an emergency arises, CARTS and other users of LCRA Community Link can switch to an emergency talk group that allows for direct communication and proactive coordination among affected agencies.

Since LCRA's radio network is used internally for voice and data communications, as well as operation of its mission critical Supervisory Control and Data Acquisition (SCADA) system, the network is extremely reliable.[4] The flexibility of LCRA's radio system and its ability to transmit digital data and messages has allowed LCRA to assure CARTS that it will have sufficient bandwidth to use the paratransit software more effectively once the AVL/MDT system is installed. In the near future, there are plans to upgrade the communications link between CARTS and LCRA to microwave because a more robust communications link is necessary. Since CARTS and LCRA have line of sight capabilities, microwave was believed to be the best type of connection to pursue.

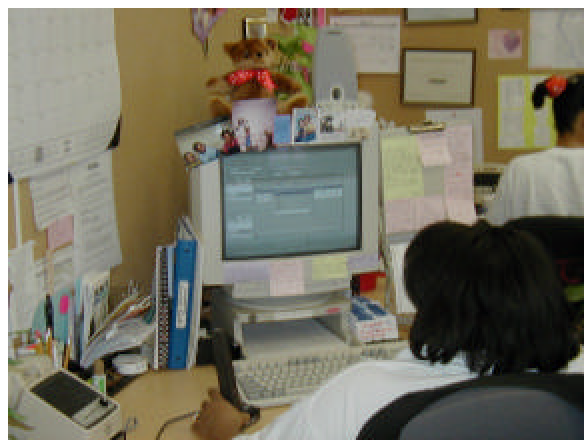
[4] The SCADA system monitors and controls LCRA's remote hardware and software.

Communication takes place between towers at CARTS's headquarters and the LCRA's towers. The communications link will be upgraded to microwave in the near future.

Paratransit Scheduling and Dispatch Software

The PASS software was initially purchased as part of CARTS's customer service initiative, in order to ensure that all customers are treated equally. CARTS completely revamped its approach to reservations, scheduling, and dispatch in order to make the most effective use of the new software. CARTS uses separate reservation agents, dispatchers, and a scheduler who is responsible reviewing the schedules and revising them as necessary.

When CARTS purchased the software in 1994, it was considered state of the art, proven software. This was the first successful installation of this software in a purely rural transit system. The technology uses a separate server and computers for each workstation, including stations for supervisors and management. There are currently 12 workstations, all located at the agency's headquarters. During peak hours the system was somewhat slow, so CARTS replaced its computers on a regular basis with more powerful machines to ensure maximum use of the technology.



CARTS schedulers use the Trapeze PASS software, which has allowed them to become more specialized in their tasks.

Trips are scheduled by the software based on the vehicles' assigned areas. There are typically few vehicle choices that the software has to make. Often there is only one vehicle that can take a particular trip request. Most of the scheduling is done with the use of Trapeze's software. While batch scheduling is not offered by the software, CARTS's staff do not feel this is an issue, particularly since there are areas in CARTS service area that have not been mapped. Further, schedulers feel they can do batch scheduling more efficiently than the software would be able to.

AVL/MDT System

CARTS anticipates a phased procurement, during which they will purchase approximately ten MDTs in the first phase, with additional purchases to include the entire fleet within one year. There are two major objectives to the installation and implementation of MDTs:

A. Real Time Recording of Data - It is required that the MDTs allow for all recording of basic ridership information as well as performance data that can be used to generate a variety of reports for management. The objective is a single and rapid entry of data by the driver.

B. Digital Dispatching - It is expected that the use of the MDTs will allow the dispatcher to have real time information about the status of each trip and driver, and to digitally transmit and receive instructions and data necessary for dispatch purposes (such as driver manifests). These transmissions of data and information will be virtually instantaneous (typically less than a half second delay).

CARTS selected Mentor to install and manage the installation of MDTs, and the new vendor is working directly with LCRA and Trapeze. The first task was to test Mentor's MDTs with CARTS's EDACS radio system. This task was completed as of April 2002.

Each vehicle will include an MDT with an internal GPS receiver that is connected to the radio. The XGate software will be used to interface between the Trapeze MDT server and the mobile data communications system. A fixed link will be required between CARTS and LCRA. As described earlier, a microwave connection was chosen because a good line-of-sight currently exists.

The AVL component, built into the MDTs, will poll vehicles when the MDT functions are activated. In other words, polling will occur when a transaction is initiated by the dispatcher or the driver. However, polling may also occur at specified time intervals (every ten minutes, for example).

3.5 Design, Operations, and Performance

3.5.1 Needs Assessment

In 1993, CARTS performed a needs assessment to determine the priorities and timing of the ITS deployment. Additionally, the agency had a consultant conduct a needs assessment for the MDTs. The needs assessment found that:

- There were significant data collection/reporting benefits to the technology. It is estimated that CARTS will be able to reduce approximately one full-time employee once it has installed the MDTs;
- Safety and security improvements were possible; and
- CARTS was prepared (in terms of staff and management) for the next technological step.

3.5.2 Training

Training is an integral part of the successful deployment at CARTS. Each RFP has stressed the importance of training, and the RFPs called for initial and then advanced training. In addition, CARTS employees attend annual Trapeze user group meetings in Arizona. CARTS is currently working closely with other Texas operators to start a Texas Trapeze users group. Trained staff conduct additional staff training as needed (i.e., train-the-trainer approach).

3.5.3 Maintenance of the System

CARTS mentioned the importance of technical support in the success of the technology deployment. CARTS maintains support agreements with Trapeze, and the vendor is called upon occasionally to assist the agency. The MDT procurement includes funding ($17,000 annually) to ensure support between the Mentor software/hardware and Trapeze software (in addition to the PASS annual maintenance charge).

CARTS has a need to devote a part-time staff person to technology support as his/her primary responsibility. This responsibility will increase to full-time once the MDTs are installed. This approach works better than relying solely on the software or hardware vendor, and enables problems to be resolved more quickly.

3.5.4 Operational and Other Challenges

CARTS did not report any major or unusual challenges in deploying the radio system or paratransit software. This might be explained by two factors. First, implementing components one at a time helped CARTS successfully handle issues more easily than if it had been trying to integrate multiple components at the same time. Secondly, the agency brought in consultant assistance to write system specifications and negotiate resulting contracts. This latter effort included carefully planning how different ITS components would be integrated.

Perhaps the biggest challenge for CARTS has been obtaining funding in a timely manner for a system that, by design, has been implemented incrementally. Obtaining funds and deploying multiple ITS components simultaneously might have been easier at face value. Nevertheless, CARTS maintained its incremental deployment approach and accepted the fact that it would face implementation delays because funding availability might not match its deployment schedule.

The speed of the reservation process was an issue during and shortly after start-up. When the system was first implemented, it took longer to process trip requests electronically than by hand. This problem was addressed by additional training, a change of procedures, and faster computers.

Also, the addition of geographic data to the reservation and dispatch system has been a challenge. While piecemeal GIS data updates can be done by CARTS staff, significant changes must be sent to Trapeze for formatting. With the growth in both the service area and the transit service provided by CARTS, this is becoming an increasingly important issue, particularly since the AVL system will not be able to track vehicles that leave the defined area. The agency indicated that they may hire a full-time staff person just to deal with changes to the geographic data.

CARTS initially believed that training staff who were unfamiliar and perhaps uncomfortable with new technology, such as computer software, would be a potential issue. However, staff acceptance never really became a problem, as staff had little difficulty adapting to the new technologies. However, CARTS has some concern that training will be more difficult with the new AVL/MDT system since the drivers may not be comfortable with using computers instead of voice communications. Consequently, the implementation plan includes 8 hours of training on the system for every driver and dispatcher.

3.5.5 Perceived System Benefits

CARTS has seen a number of benefits from implementing its ITS components. First and foremost is the broad goal of improving customer service. The software has allowed all passengers to receive the same treatment and level of service, by requiring a uniform approach to reservations and scheduling. Additionally, reservation agents and dispatchers are able to schedule more same-day trips and provide better connections for customers traveling between different service areas. The deployment of the

AVL/MDT system is expected to further increase customer service quality by allowing the dispatchers to make better "on the fly" schedule changes and provide better answers to "where's my bus" inquiries.

Other benefits of the CARTS ITS deployment included the following:

- The increased level of communications increases the safety of the system. By allowing dispatchers to track each vehicle's location, incidents can be quickly recognized and the appropriate resources dispatched. Thus, drivers have a greater sense of security.
- The new AVL/MDT system is expected to reduce the amount of noise on the bus created by continuous radio chatter.
- The software and the new radio system have allowed CARTS to consolidate all of its dispatch functions in one location, reducing staffing needs. This consolidation has greatly increased system performance and the uniformity of service. It also has allowed staff to be more specialized, while also allowing them to better share their duties with one another.
- It is anticipated that the MDTs will reduce staff data entry time (estimated as one half-time person).
- Through the deployment process, CARTS has developed an excellent working relationship with the LCRA. Their partnership has benefited both organizations.

3.5.6 Staff and End-User Reactions

Staff have adapted well to the technology, and drivers and dispatchers are looking forward to the MDTs. The MDTs will allow drivers to work in a paperless environment and reduce their data entry requirements to the push of a button. Drivers and dispatchers especially seem to like the I-call feature of the radio system, which allows them to communicate without broadcasting over the entire system.

Customers, for the most part, do not see the technology at work, and do not know it is beneficial. However, even though customers do not realize it, the technology is making the trip safer and more efficient. It is also allowing the reservations agent to work more quickly, thus reducing call time and hold time.

3.6 Project Costs and Revenue Sources

There are a number of different costs associated with the implementation of technologies at CARTS. Each of the three major technologies – software, radio and MDT - have initial start-up costs, capital costs, and on-going maintenance costs. In addition, there are costs associated with staff time and effort in implementing and managing the technologies.

3.6.1 Costs

Radio System

The infrastructure costs associated with the radio system are the responsibility of the LCRA. CARTS was responsible for purchasing the on-vehicle units (two-way radios), which cost them approximately

$1,600 each. CARTS also pays the LCRA a fee of $25 per month for each on-vehicle unit. Once MDTs are installed on the vehicles, this fee increases to $35 per month, per vehicle.

Software

The initial cost of the software for CARTS was $60,000 in 1994. Since that time, CARTS has needed one major upgrade to Windows, which cost approximately $50,000. For the MDTs, the Trapeze software and installation costs were about $50,000. Total cost for Trapeze was approximately $160,000 for the original software, Windows upgrade, MDT upgrade, and installation. Ongoing costs are approximately $10,000 per year for software support.

MDT

The MDT installation, including all software and use of the tower, cost approximately $160,000. This cost includes the first 10 MDT units. The ongoing support cost (including the PASS software for MDT interface) for the MDTs is about $17,000 annually.

3.6.2 Revenue Sources

Revenue sources for the most part came from FTA and TxDOT. Other funding has not been available for the ITS project. Funding, in part, is the reason that all of the ITS components were not procured and installed at the same time. Funding first became available for the paratransit scheduling and dispatch software. CARTS did not have the funding to purchase the AVL/MDT system until a few years later.

3.7 Considerations/Best Practices

CARTS is one of the few rural systems to have successfully deployed more than one technology. In fact, they have successfully deployed two technologies and are moving forward on a third major technology deployment. This unprecedented success in a rural transit environment is an example for other transit systems some lessons in successful implementation. There are a number of activities and approaches that have value for other systems preparing to invest in and deploy technologies.

3.7.1 The Planning Process

The CARTS ITS planning process contributed significantly to the eventual success of the technology. Planning for the radio system started as far back as 1990 when CARTS learned that LCRA was planning its radio system. As part of the initial procurement for software, CARTS, having never purchased technology, sought the assistance of a consultant to assist in the design and procurement of the paratransit software. The focus of the planning effort was to identify system needs and to set realistic goals and expectations.

The planning effort concentrated on procuring and implementing proven technology. CARTS was not technologically sophisticated at the time of the initial software procurement, necessitating the need for proven, successfully implemented technology. CARTS did not want to be a test site for new software and attempted to "keep it simple." Additionally, since each component of the system was installed separately, CARTS thought carefully about the integration of the different components prior to installation. Given the difficulty with integration experienced by other agencies that have installed multiple ITS components, the forethought given to integration by CARTS is a valuable lesson to other agencies looking at similar projects. Additionally, CARTS continued thinking about integration issues throughout the procurement process.

3.7.2 The Procurement Process

Each RFP was developed using functional specifications. That is, CARTS wanted the technology to do certain things that were detailed in the RFPs, but the vendors had some flexibility in deciding how they would meet these specifications. The software and MDT/AVL specifications and RFP were developed by a consultant with extensive experience in the procurement and installation of technology. Thus, proposing firms gained a clear understanding of exactly what CARTS wanted from the technology. At the same time, competitive proposals from a number of potential firms were sought.

Additionally, CARTS carefully considered the integration of the various ITS components during the procurement process. For example, LCRA has participated in CARTS's AVL/MDT procurement process to ensure that the proposed equipment and data transmission requirements will be consistent with the radio infrastructure and capacity. CARTS required that the successful AVL/MDT vendor subcontract with LCRA to participate.

3.7.3 The Installation Process

CARTS elected to have separate contracts with the software vendor, the hardware supplier, and the network supplier when purchasing the software in 1994. This resulted in additional work for CARTS staff to manage the project and considerable “finger pointing” among vendors. No one entity was responsible for success, and each blamed the other for problems.

When CARTS procured the MDTs, it required the cooperation and assistance from not only the MDT vendor, but Trapeze and the LCRA as well. It was decided that there would be one entity (a systems integrator) responsible for all aspects of the work. Mentor was required to enter into agreements with Trapeze and LCRA to ensure that all parties worked together. Mentor is solely responsible for the implementation and on-going support of the MDTs.

Throughout the installation processes, CARTS has also placed a high level of importance on incremental start-up and testing procedures. For example, the MDT implementation included a pilot phase in which the live system was installed on only a portion of the fleet. The purpose of the pilot was to "complete end-to-end testing of the Mobile Data System under real-life conditions so that any remaining system issues (could) be identified and addressed.'[5] Furthermore, full installation was initially done on only 10 of the agency's vehicles so that those vehicles could be used to de-bug the system prior to installation on the entire fleet. Additionally, contractually specified testing procedures existed throughout the installation phases of the MDT deployment, including an "Acceptance Period" prior to conclusion of the project.

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[5] Source: CARTS Implementation Plan by Mentor Engineering.

3.7.4 Operations

CARTS learned a number of valuable lessons when implementing the various technologies. These included:

- Try to anticipate the organizational changes that may be necessary once the technology is implemented so that minimal organizational issues arise once the deployment is completed.
- Have competent, trained staff that are willing to accept change.
- Ensure that additional training is available for key staff.
- The agency must have a well-run system, as the technology will not necessarily help a poorly run system.
- Think about having a staff member at the agency who can deal with technical issues, so as not to rely solely on vendors for technical support.

3.7.5 Other Considerations

CARTS is an excellent example of successful rural transit ITS. CARTS management believes that its key to success has been a slow, measured approach to implementing technology. That is, one technology is implemented and perfected before another technology is implemented. In addition to those listed above, there are a number of other simple lessons CARTS has learned that can be passed on to other rural (and even urban) transit systems:

- Each technology had a purpose(s) for which it was purchased. CARTS management knew exactly what was needed and why.
- Expectations of CARTS's staff were reasonable.
- Training was emphasized and continues to be a priority.
- CARTS had a facility designed to enable staff to work efficiently and effectively.

3.7.6 Unexpected Benefits

Surprisingly, as each of the ITS components has been added, CARTS has found few, if any, new uses or applications for the technologies. Rather, the utility of the components has been improved by subsequent deployments. For example, the AVL/MDT installation builds upon the utility of the radio system, thus making it an even more useful component. Similarly, the AVL/MDT system will enhance the capabilities provided by the reservation and dispatch system by providing better information about the status of vehicles.

3.8 Future Plans

In keeping with CARTS's goal of improving customer service, management is looking to expand their Web page, possibly with the addition of an automated itinerary planner. The Web page will initially be for customer information, but management ultimately sees the possibility of passengers scheduling their own trips through the Internet.

A second area of interest to CARTS in the future is a smart card system. One example cited by management is the card that many human service clients use for services. CARTS would like to use that card as a smart card, tracking the customer's usage for the appropriate agency and using the information for billing purposes.

4.1 Case Study Overview

The research team visited three sites in rural Florida to conduct a case study of a statewide, phased ITS deployment. The demonstration project involves installation of hardware and software at various rural transit provider locations. The rural transit providers, called Community Transportation Coordinators (CTCs), are all part of the statewide project undertaken by the Florida Commission for the Transportation Disadvantaged (CTD), an independent commission housed administratively within the Florida Department of Transportation. The project was one of the first five rural ITS projects funded by the U.S. Department of Transportation.

The CTD believes that transit ITS projects have often lacked a systematic planning process and have not been clearly connected to rural transportation needs. The agency initiated its Rural ITS Demonstration Project to rectify this situation in Florida, and was given funding and project development support from the FTA. The CTD anticipates that its Rural ITS project will help address a number of transportation access issues face by the CTCs, including the following:

- Low productivity of paratransit services;
- Need for increased administrative efficiencies;
- Lack of inter-county trip coordination;
- Lack of intra-county trip coordination; and
- High cost of long-distance, out-of-county trips.[6]

Florida's rural ITS project entailed installation of hardware and software at select CTCs under the supervision of the CTD. The participating CTCs received start-up funding to purchase personal computers and various ITS technologies, including:

- Mobility management software applications which, in many cases, included Geographic Information Systems (GIS);
- Global Positioning Satellite (GPS) - based Automatic Vehicle Location (AVL) systems; and
- Mobile Data Terminals (MDTs);

Phase 1 of the project has been completed, and Phase 2 is scheduled for completion in December 2002. Phase 1 and Phase 2 of the project included installation at five different CTCs:

- The Flagler County Council on Aging;

[6] Source: Northeast Florida Rural Transit ITS Evaluation Plan, Battelle and the Volpe National Transportation Systems Center, May 2001 – funded by the ITS JPO as part of their National Evaluation.

- The St. Johns County Council on Aging;
- ARC Transit, Inc. (Putnam County);
- Coordinated Transportation System, Inc. (Alachua and Levy Counties); and
- Marion County Senior Services.

Phase 3 will expand the project to one additional county, namely Union County.

4.1.1 CTD Overview

The CTD coordinates human services transportation in all 67 rural Florida counties. The agency's mission is to ensure the availability of efficient, cost-effective, quality transportation services for transportation-disadvantaged persons. The CTD has a 27-member state-level policy board. The agency has organized Local Coordinating Boards to oversee the local transit services provided by the 45 statewide CTCs. In addition to establishing funding for the CTCs, the CTD provides them with technical assistance to enable the implementation of cost effective and efficient improvements to service, including ITS solutions.

The CTD believes that ITS is a set of potentially valuable tools to enhance transportation management and operational needs of the CTCs. To use ITS toward this end, the CTD applied for and received the first of five rural ITS grants from the U.S. DOT in 1997. This grant allowed them to establish an ITS project to demonstrate the application of mobility management software, AVL, and MDTs at the CTCs. The CTD’s goal for its Rural ITS Demonstration Project was to evaluate the impact and determine the benefits of ITS on operational productivity and efficiency in scheduling, driver accountability, and billing. The CTD has provided and continues to provide technical assistance to participating CTCs.

4.1.2 CTC Overview

All rural transportation in Florida is arranged or provided by the CTCs. CTCs may either provide transportation directly or contract with local transportation operators through a competitive procurement process. While the CTCs are independent organizations, each one has a Local Coordinating Board, which is responsible for overseeing the CTCs activities. Each CTC is allowed to develop unique rate structures and implement transportation management software of their choosing. However, under the Rural ITS Demonstration Project, participating CTCs have been encouraged to use the same off-the-shelf software product.

The structure and function of the CTCs vary in different locations throughout the state. These organizations include single and multiple county operations, private for-profit and non-profits, sole providers/brokers and hybrid systems. All of the CTCs included in the first two ITS project phases are private non-profit organizations. CTCs can and do provide services besides transportation. For example, the Marion County CTC provides other senior services in the area. Recent legislation in Florida requires that CTC service providers are competitively procured every four years.

The CTCs have a number of functions that relate to the ITS demonstration project:

- They coordinate the funding streams and are the gatekeepers for accountability;
- They carry passengers of different programs on the same vehicle (multi-loading);
- They report to state and local agencies, who monitor services and standards; and
- They analyze ridership for route development.

4.1.3 Case Study Field Work

The research team conducted a site visit at three CTCs on February 5 and 6, 2002. The visit was coordinated by CTD's Project Manager, Mary Constiner-Freeman. In addition to organizing meetings with staff from each of the CTCs, Ms. Constiner-Freeman accompanied the research team to each of the selected CTC sites and provided invaluable insights and information.

The CTC sites chosen jointly by Ms. Constiner-Freeman and the research team were:

- St. Johns County Council on Aging;
- Putnum County Ride Solution; and
- Marion County Senior Services.

Meetings were held with key administrative and operations staff at each organization. Although the CTD worked with Flagler County as the first deployment site, the research team and Ms. Constiner-Freeman decided that a more accurate picture of project implementation would be obtained by starting with the second deployment site, St. Johns County. Putnam County was chosen because it had decided to continue developing a proprietary mobility software program it had already invested in, rather than using the state's recommended solution. Marion County was included in the case study because it was the most recent installation site and there were indications that it had made progress in working out bugs experienced in previous deployments and maximizing its use of the software.

4.2 Project Background and History

The statewide program is being implemented in three phases. For all practical purposes, this case study primarily covers Phases 1 and 2, which had been fully implemented as of February 2002. Phase 3 is discussed in the section on future plans.

4.2.1 Phase 1

The CTD and the Federal Transit Administration (FTA) entered into a $200,000 demonstration grant agreement in October 1997. The first phase of the project included the use of off-the-shelf paratransit software to facilitate inter-county coordination of passenger trips from rural to urban areas. Three county CTCs were recruited to participate - Flagler, St. Johns, and Putnam Counties. These counties were selected partly because they are contiguous, mostly rural, and have large urban medical facilities located outside of their designated service areas. The first project phase extended from October 1997 through October 1999.

The project began with operational studies of each CTC to identify potential opportunities and challenges in deploying an ITS system. These studies assessed the current technology, software, and hardware installed at the CTCs. None of these service providers used software specifically designed for paratransit operations. All relied on some combination of computer spreadsheets, simple databases, and paper forms for data entry, record keeping, and scheduling. In general, the CTCs also did not have computerized mapping software. The exception was Putnam County Ride Solution, which had an existing scheduling and mapping software system that it wanted to continue using. Overall, the results of the operational studies led to recommendations to upgrade computer hardware and software required to run a paratransit software package and later to interface with AVL, MDTs, or other rural transit ITS applications.

During Phase 1, the CTD also established formalized institutional arrangements with the project participants, including CTD project managers, the participating CTCs, and an independent evaluator, who was brought in at the end of the phase to evaluate the success of the project to date. In October 1998, the participants signed a Memorandum of Understanding (MOU), which defined the roles of each participant.

Overall goals for Phase 1 included:

- Facilitate regional service delivery through the use of regional mapping in transportation management software;
- Develop transfer points based on GIS analysis of travel patterns recorded and mapped with paratransit software;
- Develop modified service routes, based on a pattern of regular or standing order paratransit trips;
- Improve operational efficiency so more trips could be scheduled; and
- Analyze regional fixed route systems to promote further expansion of regional services.

The CTD selected and procured the paratransit software to be installed at the CTC sites. The Phase 1 demonstration grant specified that the technology had to be “off the shelf." There was no formal bid process for the software. Instead, CTD staff worked with several CTC representatives to choose the software product. RouteLogic’s ParaLogic routing and scheduling software was selected. It was installed at all three Phase 1 CTCs. Flagler County had the software fully installed and operational by September 1998. St. Johns County’s installation was complete by December 1998, and Putnam County had the software installed on one workstation by October 1998 so that it could interface with the other project participants.

Phase 1 also included procurement and installation of AVL units in Flagler and St. Johns County, although these units were limited to a few vehicles used for out-of-county trips. Putnam County, which already had AVL installed on some vehicles, received new AVL/MDT units for their entire fleet during Phase 1.

As mentioned above, an evaluation was completed at the end of Phase 1 to look at how well the software was working and where it needed fixes or improvements. Major findings of the study concluded that the state's ITS project had improved scheduling, reduced staff requirements, increased vehicle productivity, and improved the billing process for CTCs. The study also showed that the project had been marginally successful in promoting inter-county coordination and trip making, one of the major goals. However, the CTD believes that Medicaid reimbursement requirements may have negatively affected the project's ability to significantly increase inter-county coordination. Additionally, demographic shifts limited the need for inter-county coordination. For example, Flagler did not have the need to take a significant number of people out of the county for medical trips. Nonetheless, St. Johns County and Putnam County were able to establish limited necessary inter-county coordination.

4.2.2 Phase 2

The CTD received an additional $200,000 from the FTA for project expansion in October 1999 and invested another $50,000 of its own funds for Phase 2 of the ITS deployment. The funding was to act as seed money to expand agency participation. New trip types included welfare-to-work trips and service links to existing fixed routes in adjacent urban centers. In Phase 2, the ITS project will advance to full implementation. Phase 2 is scheduled for completion at the end of December 2002. The funding was used to install the ParaLogic software at two new CTCs, which operate service in three contiguous rural counties (Marion, Alachua, and Levy Counties). The CTCs were chosen based on their system size, the geographic location of their service areas, and the fact that they provide long-distance, out-of-service-area trips.

Additionally, RouteLogic's RouteMap software, which can be used for planning purposes, was installed at the Ocala/Marion County MPO. The MPO brokers the SunTran fixed route service in Marion County. The MPO and the CTD have an agreement that outlines the MPO's participation in the Rural Florida ITS demonstration project. The MPO's responsibilities include (but are not limited to) use of the software to identify service routes and stops in the SunTran system, identify the ADA service area, identify feeder routes to the fixed route system, and identify possible park-and-ride locations.

Phase 2 also included funding for additional hardware and software upgrades for the Phase 1 participants. Flagler and St. Johns Counties initially planned for the procurement of upgraded AVL/MDT units. However, as of August 2002, they no longer had funds remaining for this purchase. During this phase, fixed route overlays were also to be developed for the paratransit software's GIS engine so that CTCs could begin more detailed travel route analysis. Additionally, RouteLogic worked on the interface between its software and the new AVL systems that were installed in Flagler and St. Johns Counties during Phase 1. The integration between Putnam County's AVL system and their proprietary mapping and scheduling software was done by another contractor, Visual Risk Tech.

4.2.3 Descriptions of Participating CTCs

The following paragraphs briefly describe the five CTCs included in the first two project phases of Florida's Rural ITS deployment. A more detailed discussion of deployments in Flagler, St. Johns, and Marion Counties, where site visits were conducted, is provided later in this case study.

Flagler County

With a population of slightly more than 40,000, Flagler County is a small but rapidly growing county that contains no major city and, thus, no fixed route service. Flagler County is located on Florida's northeast coast and is bordered by St. Johns, Putnam, and Volusia Counties. Approximately 80 percent of Flagler County's population resides in the unincorporated areas of the county. The county has a population density of only 68 persons per square mile, making it primarily rural in nature.

The CTC for Flagler County is the Flagler County Council on Aging and its Flagler County Transport (FCT) subsidiary. The FCT also provides transportation services for other human service agencies in the County. FCT has a 21-vehicle fleet and provided approximately 76,000 passenger trips during Fiscal Year 2000.[7] When Phase 1 was initiated, the CTC had 23 full- and part-time drivers, 25 volunteer drivers, three operations staff, 10 full- and part-time support employees, and two maintenance employees. Although Flagler County had no fixed route service, their demand response service had evolved into a number of modified service routes. Prior to joining the ITS demonstration project, the county was performing most of its functions manually, although they did own some basic computer hardware and software.

St. Johns County

St. Johns County is located in northeast Florida and has a population of approximately 120,000. Although the county includes a relatively large incorporated area, St. Augustine, more than 80 percent of its population resides in unincorporated parts of the county. While St. Johns County has a considerably higher population density than Flagler County (148 persons per square mile), it is still largely rural in many parts of the county. St. Johns is also one of the 10 most rapidly growing counties in Florida.

The CTC in St. Johns County is the Council on Aging (COA), which is headquartered in St. Augustine. The COA operates coordinated agency and general public paratransit services, as well as a new fixed route in the St. Augustine area. The system has about 3,000 regular clients, many of whom receive other support services in addition to transportation. The COA operates 39 vehicles, provides about 500 trips per day on paratransit, and another 150 per day on the fixed route system, resulting in the provision of approximately 150,000 trips annually. Clients must schedule demand-response trips 24 hours in advance but no more than one week in advance, unless they have a standing order. Approximately 40% of the paratransit trips provided by the COA are standing order trips.

The COA has a number of agency contracts that require billing on a variety of bases (e.g., Medicaid requires billing by passenger mile, while other agencies are billed based on a per person or per trip basis). Prior to joining the ITS demonstration project, the CTC in St. Johns county was performing most of its functions manually, although it had installed a DOS-based transportation management software package that it later found to be inadequate in meeting the agency's needs.

Putnam County

Putnam County is located east of Gainesville and north of Ocala. The county has a population of approximately 70,000, 75 percent of which resides in the unincorporated areas of the county. The largest incorporated area of the county is Palatka. Putnam County is predominantly rural, with an

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[7] Source: CTD Annual Rural Intelligent Transportation Systems Demonstration Grant Report, 2000.

average population density of 92 persons per square mile. The County is growing, but not as quickly as Flagler and St. Johns counties.

The CTC in Putnam County is ARC Transit, Inc., a subsidiary of the Putnam County Association for Retarded Citizens (ARC). The service is called "Ride Solution" and consists of deviated fixed or "flex" routes as well as some limited paratransit services. All routes are open to the general public. Ride Solution utilizes 42 vehicles and provides about 136,000 annual trips (approximately 525 trips per day). Staff include 20 drivers, three operations staff, three part-time support employees, and three maintenance employees. The system has about 70% standing orders, 20% call-ins, and 10% walk-ons.

Ride Solution was the most technologically advanced of the Phase 1 and Phase 2 participants. Prior to participating in the ITS project, the Putnam County CTC already had a proprietary routing and scheduling software program that had been developed by an outside consultant and had been used to develop modified service routes. Consequently, Ride Solution's service was based almost entirely on the modified service route delivery model. Furthermore, the operator had already installed AVL/MDT units on a portion of its vehicle fleet. Its participation in the Rural ITS program included an expansion of the software already in use and procurement of new AVL/MDT units for the county's entire vehicle fleet.

Alachua and Levy Counties

Alachua County is in northeast Florida and has a population of approximately 200,000. Gainesville is a centralized urban population center and the County Seat of Alachua County. Approximately half of the county's population resides within the City of Gainsville's urbanized area. Gainesville is home to Santa Fe Community College and the University of Florida, as well as six hospitals. Gainesville is the primary medical center for residents living along the northwestern coast and central Florida.

Levy County is on the Gulf of Mexico, south of Gainesville and west of Ocala. The county has a population of approximately 32,000 persons, 70 percent of whom live in unincorporated areas of the county. With an average population density of only 26 persons per square mile, Levy County is one of the more rural counties included in the first two project phases.

Rural public transportation in Alachua and Levy Counties is provided by the same CTC. When the counties were selected to participate in Phase 2 of the ITS project, Coordinated Transportation System, Inc. (CTS) was acting as the CTC for the two counties. However, competitive procurement for the CTC designation was conducted during FY1999-2000 and the contract was awarded to a new private, for-profit organization. CTS still operates service in Alachua and Levy Counties under contract to this new company. The switch of CTC designation to a private, for-profit organization in Alachua and Levy Counties led to some non-disclosure issues with the mobility management software, since the new CTC had developed its own software product. Consequently, Alachua and Levy Counties ceased participation in the demonstration project in late 2000. Their hardware and software were removed from CTS's offices and placed into the office of the Union County CTC.

Marion County

Marion County is the largest of the counties included in the first two phases of the Rural ITS project, but is still predominantly rural in nature. The County is located south of Gainesville and has a population of close to 250,000. The County Seat is Ocala, which is home to two large hospitals and the Central Florida Community College. The urbanized areas of Marion County are home to approximately 68,000 people. Therefore, the majority of Marion County residents live in the unincorporated areas of the county.

Marion County Senior Services (MCSS) is the CTC for Marion County. MCSS operates Marion Transit Services (MTS), which provides coordinated paratransit and complementary ADA service for the fixed route system, which is operated by SunTran. Additionally, MCSS contracts with three other operators to provide overflow, evening, weekend, and stretcher trips. MCSS also has an agreement with SunTran to screen eligible Medicaid recipients for fixed-route system passes and to distribute bus passes to passengers who are functionally able to use fixed-route services. Planning for both MTS and SunTran is provided by the Ocala/Marion County MPO.

MTS operates 82 vehicles in Marion County, with 89 drivers, eight operations staff, 31 support employees, and seven maintenance personnel. The operator provides 189,000 annual trips (approximately 725 trips per day). 40% of these trips are standing orders and the remainder are trips that are scheduled at least three days in advance. Prior to joining the ITS project, MTS was using a computerized system for reservations, but was doing scheduling by hand. The operator was having some operational issues with the reservations software, including the fact that it was not Y2K compliant. While some modified service routes had been developed with the standing order trips, much of the paratransit service provided was done on a demand-responsive basis.

4.3 Project Goals and Objectives

4.3.1 Stakeholders

The Florida Rural ITS Demonstration Project has had a number of stakeholders. The organizations that have been the most heavily involved in the deployment are the CDT and the participating CTCs. Much of the funding for the program was provided by the FTA, although the CDT and the CTCs also contributed significant funds to the project. The organizations that performed project evaluations are also stakeholders. Battelle preformed the Federal evaluation under the direction of the Volpe National Transportation Systems Center. The University of South Florida, Center for Urban Transportation Research (CUTR) was the local evaluator for Phase 1 of the deployment. For the Phase 1 local evaluation, data were collected by the Northeast Florida Regional Planning Council (NEFRPC).

The vendors who provided the technology for the system can also be considered partners in the ITS project. The following vendors participated in Florida's rural ITS deployment:

- **Route Logic:** Provided the ParaLogic software that was installed at all participating CTCs, as well as the RouteMap software for the Marion MPO. RouteLogic also did the integration between the AVL systems in St. Johns and Flagler Counties, and their ParaLogic software.

- **Hyperdyne:** Provided the upgraded Guardstar AVL units for Flagler and St. Johns Counties during Phase 1.
- **CES Technologies:** Provided the AVL/MDT units for Putnam County.
- **Visual Risk Technologies:** Nashville-based firm that provided integration between Putnam County's new AVL system and their existing software.

Additionally, Carl Thornblad, the consultant who wrote the proprietary Putnam County software could also be considered a stakeholder since his software was integrated with the AVL system installed as part of the ITS deployment.

4.3.2 Goals and Objectives

The CTD's general goal for ITS deployments is to improve management and operations for its member CTCs.

> "The CTD believes that ITS should be viewed as a set of tools for addressing transportation management and operational needs. ITS is all about real-time information gathering, analysis, and dissemination. In addition, ITS represents the integrated application of advanced data management, electronic communications, and other technologies. The CTD's goal for the Rural ITS Demonstration Project is to evaluate the impact of ITS technology on overall productivity and system efficiency in scheduling, driver accountability, and billing practices."[8]

The participating agencies had a number of specific goals and objectives for the project. Originally, the overarching objective was to facilitate better coordination of inter-county trips, which would help the counties better utilize vehicles and operators. However, Medicaid reimbursement requirements and demographic shifts have curtailed inter-county Medicaid trips, which represent about one-third of the CTCs revenues. Thus, participants' ability to meet the inter-county coordination goal has been limited, although St. Johns County and Putnam County continue with some inter-county trip coordination efforts. In addition, there were a number of other project goals, many of which have been met by the ITS deployment, including:

- Coordinate paratransit trips with fixed route services;
- Improve the billing process, especially for Medicaid trips;
- Improve productivity through the use of state-of-the-art management, dispatch, and scheduling software;
- Reduce wait time for passengers;
- Reduce demand-response trips by encouraging use of fixed-route services;
- Reduce in-vehicle travel time; and

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[8] Source: CTD Annual Rural Intelligent Transportation Systems Demonstration Grant Report, 2000.

- Minimize customer complaints.

As described previously, the CTCs that agreed to participate in the deployment all had different levels of automation and operating parameters. Some were operating primarily modified service routes, while others were providing primarily demand-responsive service. Some were already coordinating with fixed-route providers, while others were not. The parties involved hoped that the technology would help them bridge some of these differences in order to better coordinate their services.

4.4 Description of the Application and Technology

During Phase 1, the CTD chose RouteLogic's ParaLogic software package for installation at the various participant sites, feeling that this software best met the functional requirements of the project. The software has been installed at all CTC locations, although Putnam County has installation on only one workstation, allowing them to interface with the other participants.[9] For most of its everyday operations, Putnam County is using the software it had installed prior to participating in the ITS deployment. ParaLogic has a range of modules including vehicle scheduling and routing, staff scheduling, trip scheduling, call-intake, mapping (using MapInfo as the GIS component), and payroll assistance. Reports can be produced using Crystal Reports software. Figure 4-1 shows the reservation screen that is part of the ParaLogic software and figure 4-2 shows the screen that is used to enter client information. This information is then stored in a database for future reference.

One of the desired functions of the software was to assist in the Medicaid eligibility and billing process. In order to accomplish this, the ParaLogic software had to interface with the state Medicaid fiscal agent's (Consultec) processing software, WINASAP2000. The participating CTCs were sent a new version of ParaLogic in November 2000, which included integration of Consultec's Medicaid processing.

During Phase 1, the CTD also installed hardware and servers configured with Windows NT operating systems and performed upgrades to the CTCs' hardware where required. Additionally, the CTD initiated procurement and installation of AVL units in Flagler and St. Johns Counties and new AVL/MDT units with card readers for Putnam County's entire vehicle fleet. In Flagler and St. Johns Counties, installation of AVL units was limited to a small number of vehicles used for out-of-county trips. The units selected for Flagler and St. Johns Counties were Hyperdyne's Guardstar AVL units. The AVL/MDT units installed in Putnam County were TRK-240 units by CES Technologies. The integration of Putnam County's AVL system with their mapping software was done by Visual Risk Tech of Nashville, while the other two counties' integration was done by RouteLogic.

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[9] As of August 2002, Putnam County was no longer using the RouteLogic software.

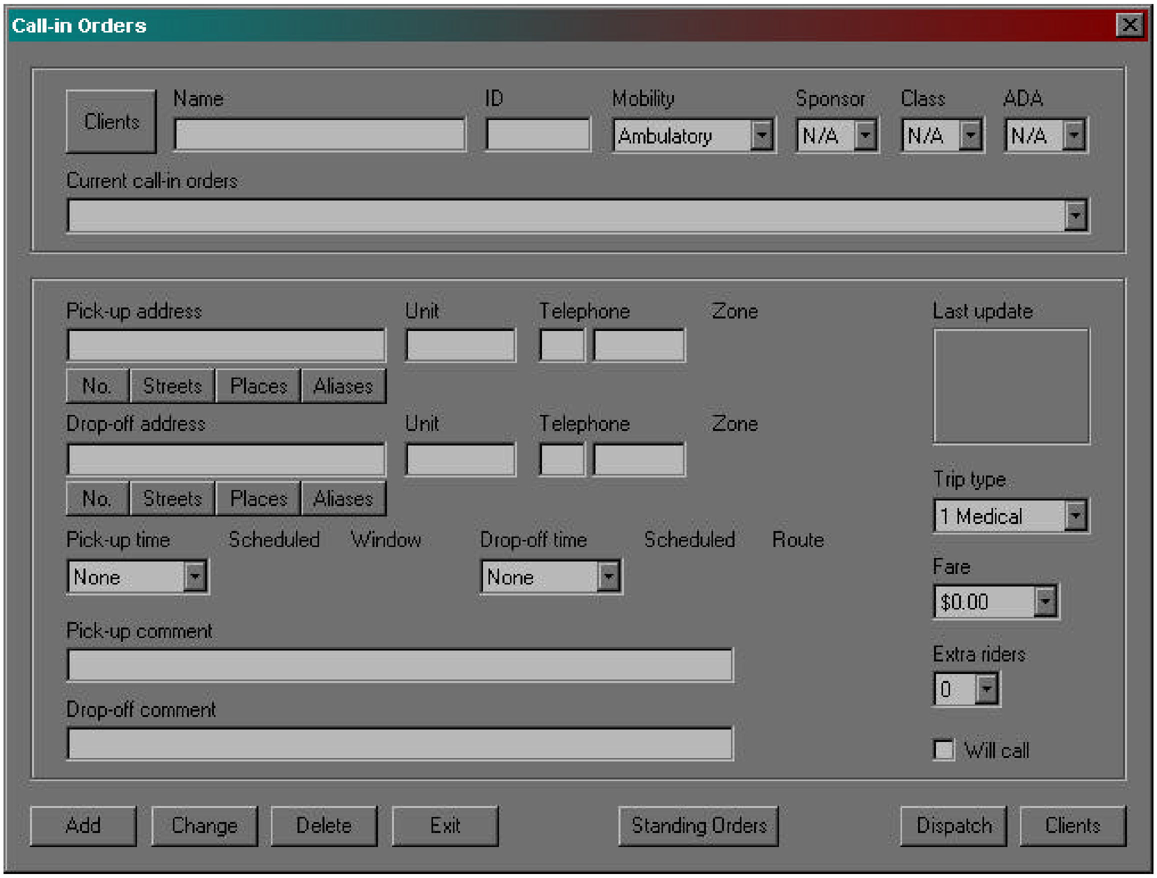

Figure 4-1: Reservation Screen in ParaLogic Software

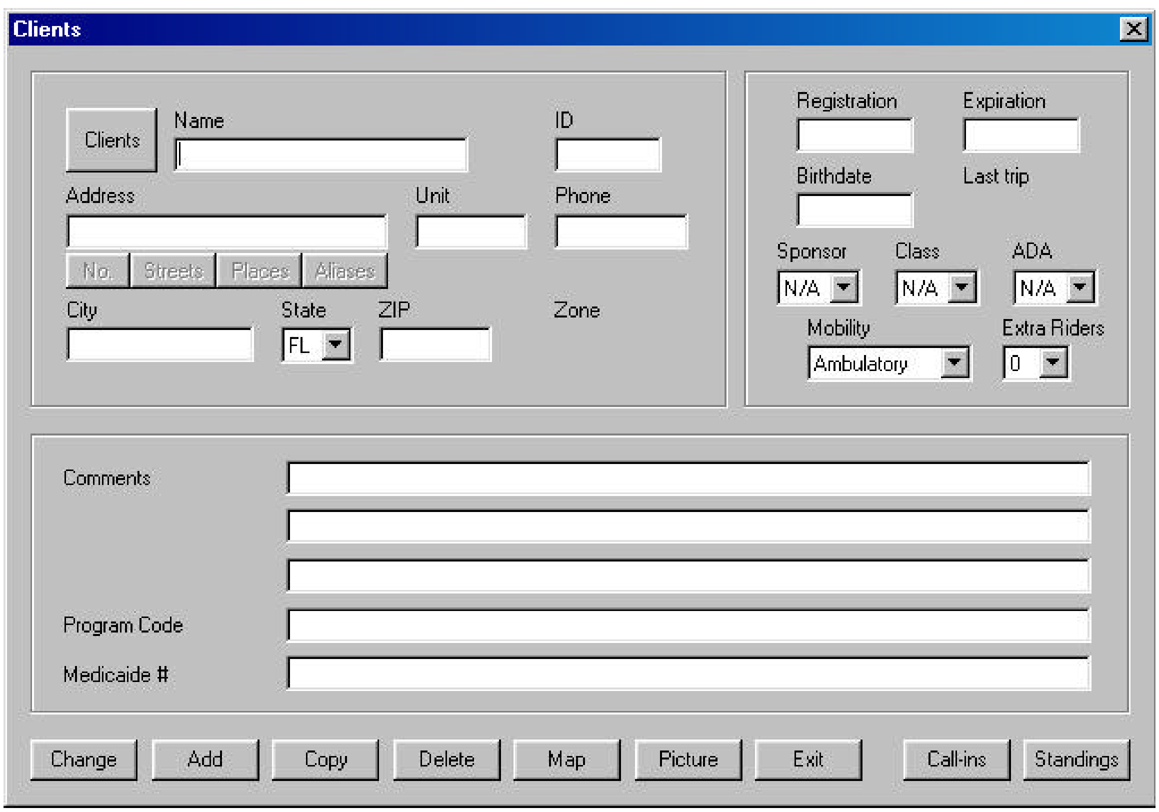

Figure 4-2: Client Information Screen in ParaLogic Software

During Phase 2, the ParaLogic software was installed in Marion and Alachua/Levy Counties. Additionally, Flagler, St. Johns, and Marion Counties planned for procurement of upgraded AVL/MDT units for their vehicles. However, due to funding constraints, they had decided not to purchase the units as of August 2002. The new units will be part of RouteLogic's Vcomm system, which includes GIS software that electronically communicates with vehicles and displays their locations on a dispatch workstation. The units are able to communicate with the dispatch station using radio or cell phone technology.

4.5 Design, Operations, and Performance

4.5.1 Needs Assessment

The CTD conducted operational studies of each of the participating CTCs in order to identify their needs and changes that needed to be made prior to the ITS deployment. The results of the operational studies led to recommendations to upgrade computer hardware and software required to run a paratransit software package and later to interface with AVL, MDTs, or other rural transit ITS applications. The CTD also spent time identifying reporting and billing enhancements to ParaLogic that would enable participants to comply with the CTD's reporting requirements.

4.5.2 Training

During both phases, the CTD facilitated vendor training on the RouteLogic software and on enhancements in new releases. Additionally, during Phase 2, Flagler, St. Johns, and Putnam County provided the new participants with a substantial amount of peer training and technical assistance for the RouteLogic software. The CTD has truly embraced the train-the-trainer approach. The new participants indicated that the peer training was especially helpful, not only from a technical perspective, but also in facilitating cooperation between members of the various CTCs. In future phases, the CTD plans to continue encouraging peer training as a way of reducing technology implementation costs.

4.5.3 Operational and Other Challenges

In general, Phase 1 of the deployment ran smoothly, while some implementation issues were encountered in Phase 2. Neither of the Phase 2 CTCs had Y2K compliant systems, which resulted in a push to complete implementation by January 1, 2000. However, the federal ITS funding did not become available to these systems until November 1999. Therefore, the participants were faced with an extremely short time frame to purchase and install the necessary hardware, train employees on the new system, and "scrub" the data to be entered into the new system.

Because of the rushed implementation deadline for these two systems, the deployment was not done incrementally, as it was in the first phase. Additionally, testing of the system was limited since it had to be fully operational within two months of receiving the funding. Consequently, the two CTCs experienced significant hardware and software problems in the first months of operation. Additionally, the agencies had a number of unexpected costs in these first months, including expenses for additional software and overtime as staff tried to get the system up and running. However, during 2001, significant progress was made towards remedying many of the problems faced by the Phase 2 participants.

As described earlier, another issues, though not directly related to the ITS implementation, surfaced in the first year of Phase 2 when a private, for-profit company was designated the new CTC for Alachua and Levy Counties. The new designation created a non-disclosure issue with the mobility management software, and lead to the removal of the two counties from the demonstration project.

4.5.4 Perceived Benefits of the ITS Deployment

When the project was deployed, the participants identified the potential benefits of the system, including the following:

- Decreased the number of out-of-county vehicle trips, since there would be better service coordination, allowing passengers to utilize multiple operators;
- Increased level of intra-county service;
- Increased productivity, since the system could help the CTCs with multi-loading (i.e., scheduling more than one passenger onto a vehicle);
- Increased attractiveness of the service to "choice" riders, which could potentially increase farebox revenues;
- More accurate and timely billing, and reduction in time spent on these administrative functions; and
- Decreased response time since vehicle scheduling would be more automated and efficient.

4.6 Project Costs and Revenue Sources

The first phase of the project, which began in 1997, was funded with a $200,000 FTA demonstration grant. Phase 2 of the deployment began in 1999 and included an additional $200,000 from the FTA and a $50,000 match by the CTD. The CTD also required a 10 percent match by each CTC participating in the project. In reality, the match at most CTCs exceeded this requirement almost threefold. The participants' willingness to continue contributing financially to the project is evidence of their commitment to seeing the deployment succeed. The specific allocation of funding for each of the project participants is listed below.

<u>Phase One Participants</u>

Flagler County	$60,000
Putnam County	$60,000
St. Johns County	$60,000
NEFRPC	$10,000
CUTR	$30,000

Phase Two Participants

Ocala/Marion MPO	$5,000
St. Johns County	$30,000
Putnam County	$5,000
Marion County	$60,000
Flagler County	$35,000
Alachua/Levy Counties	$60,000[10]

4.7 Participant Reactions

4.7.1 St. John's County CTC

St. Johns County's CTC, the COA, has been using the ParaLogic software for approximately three years. According to COA staff, the paratransit software turned the operation in St. John's County from a struggling operation to a thriving, cost-effective service. A number of years ago, the CTD and the community recognized that the COA needed substantial help on a number of management issues. For example, the COA was six months behind in its Medicaid billing and was experiencing severe cash flow problems. The community, funders and the local coordinating boards had lost confidence that the COA could provide quality transit services. With the paratransit software in 1998, the COA has been able to bill Medicaid regularly and has dramatically improved the level of service it provides to its riders. The increased efficiencies and new scheduling capabilities have even allowed the COA to solicit new funding to implement a more traditional fixed route service called the Sunshine Bus Company. COA staff feels the dramatic turnaround would not have been possible without their participation in the ITS demonstration project.

Description of the ITS Deployment

The ParaLogic software was installed on St. Johns County's computers in Fall 1998 and was fully operational by January 1999. The COA initially attempted to run the program on their existing computer, but found that they were not powerful enough to handle the software. For example, the system was so slow that trip requests had to be taken manually and then scheduled into the system at a later time. This situation was remedied when new hardware was installed in January 2000 as part of the project's second phase.

Phase 1 also included the installation of GPS-based AVL on three of the COA's vehicles. However, the organization has found this installation to be of limited use since the entire fleet has not been outfitted. Consequently, the COA has not yet realized the benefits of the technology and will likely not do so until a greater number of vehicles have been equipped with an AVL system.

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[10] Note that Alachua and Levy Counties originally participated in Phase 2 of the project, but ultimately ceased participation when their CTC designation changed.

The ParaLogic software has been installed on all of the COA's workstations and facilitates a number of functions, including scheduling and billing. Figure 4-3 shows the dispatch screen that can be viewed by dispatchers and schedulers. Although the software has batch scheduling capability, the dispatchers normally formulate service routes manually from standing orders. When the software was initially installed, dispatchers did attempt to use the batch scheduling function. However, they felt that they could schedule the subscription services more quickly and accurately by hand, given their extensive knowledge of the transit system. Thus, the base standing orders are simply saved in the automated system as regular trips. According to the COA, some of the "bugs" are still being worked out by the vendor with the batch scheduling function, so in the future the schedulers may again attempt to use this feature.

The software has helped the COA divide the county into a number of service zones. Dispatchers and drivers are generally assigned to a specific zone so that they can familiarize themselves with that area. As trip requests are received, they are routed to the dispatcher who is assigned to the zone of the trip origin. If the dispatcher is unable to schedule a trip, it goes into the "unrouted list" and is scheduled at the end of the day.

In addition to holding the standing orders and allowing the dispatchers to assign trips to vehicles, ParaLogic maintains a client database (including information about sponsoring organizations), compiles data for billing purposes (such as trip distance, as shown in figure 4-4), and formulates manifests that can be printed out for drivers. Figure 4-5 shows the client entry screen included in the software, and figure 4-6 shows an example of how the dispatcher can select from a number of manifests to print. The system can also print maps for new drivers who are unfamiliar with their service areas. Ultimately, the software will also allow the COA to check Medicaid eligibility through a link to the state's Medifax system. The COA has found that the information maintained in the system is helping them tremendously with their Medicaid billing process.

Training

All transportation staff at the COA were trained on functions related to their respective tasks, as well as cross-trained on other functions of the system. The COA received training from RouteLogic, and has also taken advantage of peer-to-peer training opportunities, particularly from Flagler County, which has acted as the pilot for many of the system components and upgrades. Also helpful was the fact that the COA hired a new Director of Operations, who had been involved with the Flagler County CTC when it began using the paratransit software.

On a day-to-day basis, staff at the COA rely on the software's help screens for assistance since no manual was provided with ParaLogic. Staff at the COA feel that the formal training could have been better, and that training after upgrades is particularly scarce. However, their use of the peer-to-peer training network has helped somewhat with this issue.

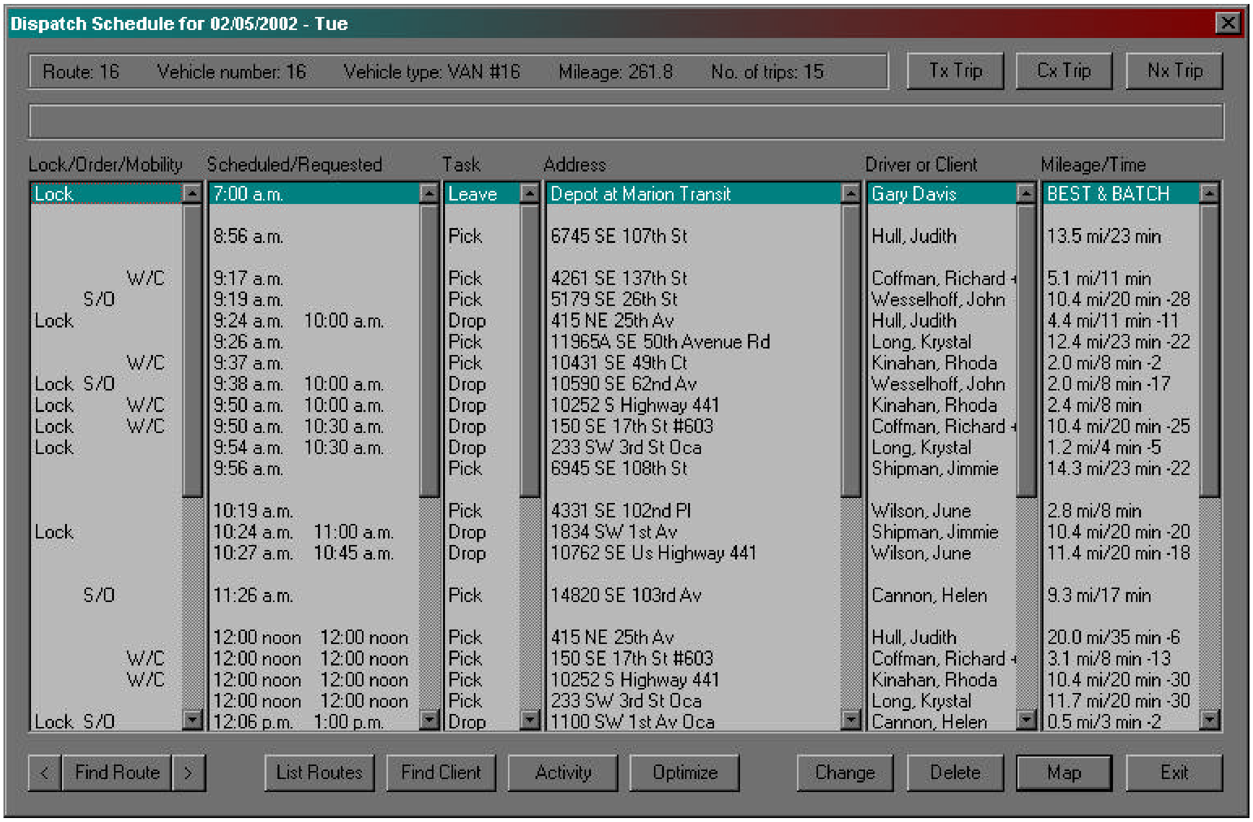


Figure 4-3: Dispatch schedule screen in ParaLogic Software

Benefits of the ITS Application

Managers in St. Johns County noted a number of benefits resulting from their participation in the Rural ITS project. They found the operational studies to be very helpful, independent of the ITS application. The operational analysis forced them to carefully examine their system and recognize what they were doing well versus what could be improved upon. As a result of the analysis, the COA brought in an outside consultant to help with the deployment.

One of the more significant advantages of the new software is that it has allowed the schedulers to enter subscription routes (modified service routes) into the system. These modified service routes are comprised of standing orders. The schedulers then schedule other trip requests around these modified service routes. The COA feels that this practice has reduced the amount of time required to schedule trips, added predictability to their operation, and increased vehicle productivity.

Additionally, the ITS project has allowed the COA to establish cooperative agreements with the Flagler and Putnam County CTCs. For example, prior to participating in the ITS program, the COA would typically have to assign a vehicle and driver to stay in Gainesville all day when a client had an appointment at one of the Gainesville hospitals. The improved coordination has allowed the COA and the Putnam County CTC to agree on a transfer point so that the CTC in Putnam County takes St. Johns' clients to the hospitals. Thus, clients can more easily make

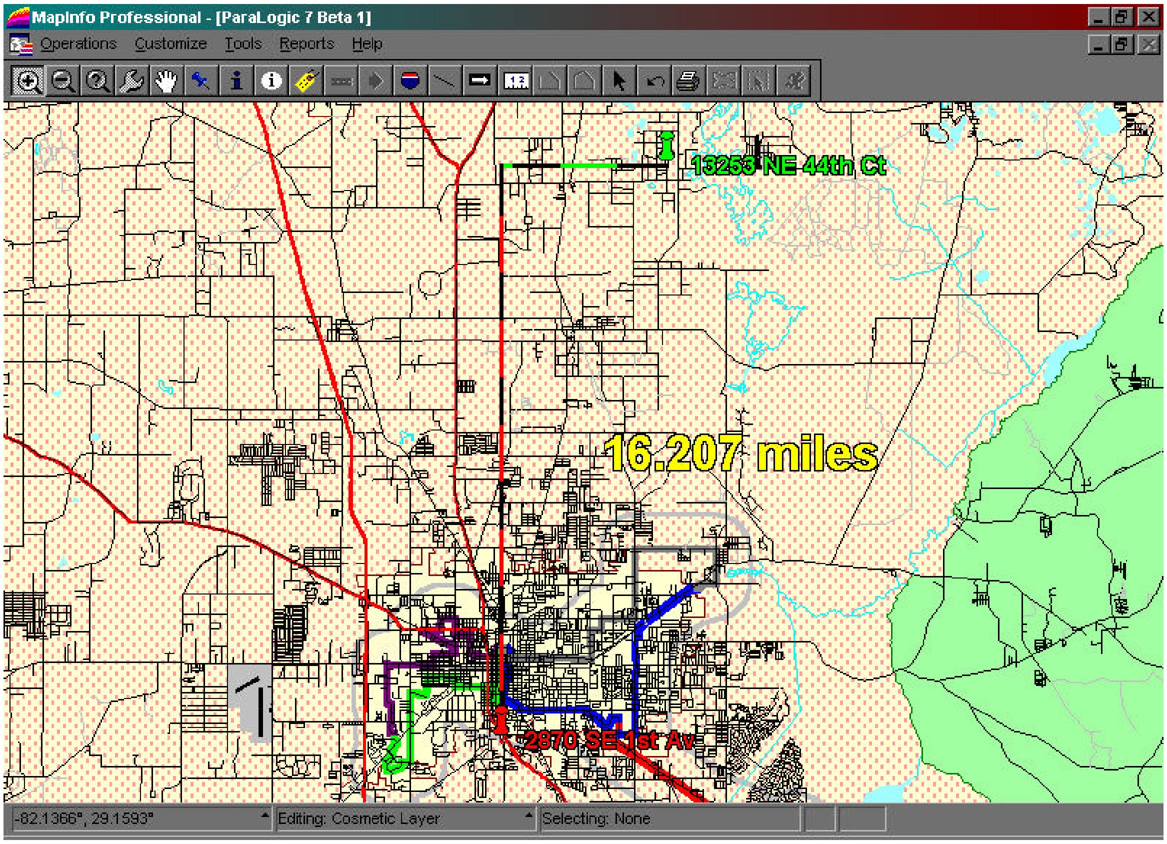


Figure 4-4: Client Route Path and Computed Trip Distance

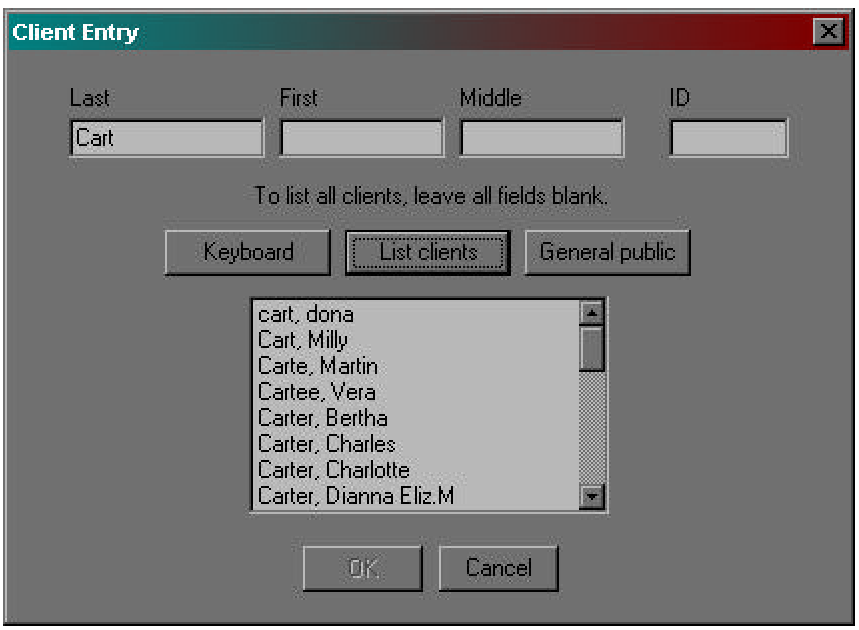


Figure 4-5: Client Entry Screen in ParaLogic Software

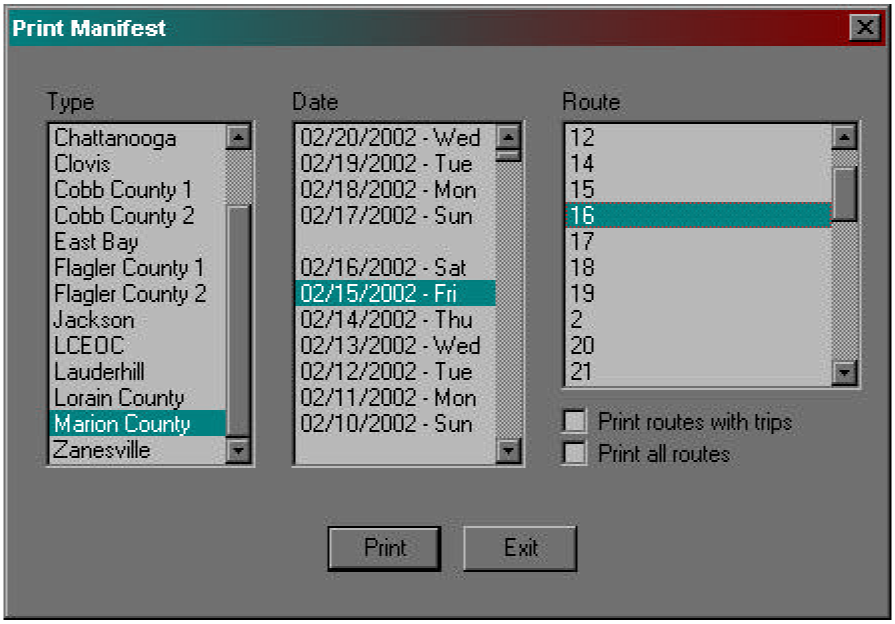


Figure 4-6: Print Manifest Screen in ParaLogic

these longer, inter-county trips. This arrangement is exactly the type of coordination the CTD had hoped would develop with the ITS deployment.

On a more quantitative level, management staff report that the software has allowed them to reduce their intake, billing, and schedule staff by half. Improved scheduling procedures (multi-loading and development of "fixed" routes) allowed them to provide more trips per hour with better on-time performance and greater customer satisfaction. The software allows them to build and maintain repeat customer trips with little time or effort. Intake operators can usually schedule trips onto the routes when reservations are taken, rather than having to call customers back once they have found an available time. Specific improvements achieved as a result of the ITS deployment include:

- The COA has reduced the administrative staff associated with call intake and reservations, scheduling, dispatch, and billing from 8 to 4.5 staff positions.
- They have increased the number of group trips and improved scheduling efficiency. Specifically, productivity has increased from .5 trips per vehicle hour three years ago to 2.5 trips per vehicle hour currently.
- The billing coordinator has been reduced from a 40-plus hour position to a 20-hour per week position.
- The COA has been able to more efficiently schedule drivers, which has minimized driver costs, reduced vehicle time, and reduced the number of split shifts necessary to meet customer demand.

Other Considerations

One of the challenges COA faced was dealing with the amount of "scrubbing" needed in order to integrate their customer database with the new software. They needed to make significant changes to all customer addresses so that they would be compatible with software. Agencies should realize that data preparation may be a significant effort when a new system is to be implemented.

The COA also feels that they underestimated what was needed in terms of computer hardware capabilities, even though operational analyses were done. On paper, it appeared that their computers met the vendor specifications, but in practice, the computers were not powerful enough to deal with the software. Additionally, the quality and type of hardware is an aspect that should be carefully considered by agencies installing new software. COA had "locally built" computers that did not have the video cards and components needed for the intensive mapping provided by the software. Thus, they ended up having to completely upgrade their computer hardware after the software had been installed.

Finally, one of the unexpected benefits of the ITS deployment was increased community confidence in the COA's ability to operate an efficient, effective transportation system. The increased community support has allowed the agency to successfully lobby for a grant to implement a more traditional fixed route service.

4.7.2 Putnam County CTC

Putnam County's Ride Solution was the most technologically advanced of the Phase 1 and Phase 2 CTCs prior to joining the ITS demonstration project. Prior to joining the project, Putnam County already had an AvTrax AVL system installed on 13 of its vehicles. The AVL system had been installed in 1994. Full implementation on the entire fleet had initially been planned, but was curtailed when funding was cut due to a Medicaid crisis. Additionally, the county had a Mapix mapping system, a cardreader system by Canyon Development, and RIDES Management Software by Management Analysts (proprietary to Ride Solution).

Although the majority of their service is comprised of modified service routes based on subscription trips, Ride Solution also provides traditional demand responsive service.

Prior to becoming involved in the demonstration project, Ride Solution had already formulated a number of modified service routes based on standing orders. Their AVL system and their scheduling software helped in creating these modified service routes, which were based on a computer-generated analysis of demand-responsive patterns. Ride Solution also has a shuttle run to Gainesville that serves as the transfer point for other counties in the ITS project. Although the majority of their service comprises modified service routes based on subscription service, they do also provide more traditional demand responsive transportation service. These trips are scheduled into the slots available between the regularly scheduled service.

Ride Solution provides a fixed route shuttle to Gainesville, facilitating inter-county transfers.

Description of the ITS Application

Since the scheduling and dispatch software had been specifically developed to meet Ride Solution's needs, the operator chose to continue using the proprietary software instead of switching to ParaLogic. However, they did install ParaLogic on one workstation so that they could coordinate with the other participants. With the new ITS funding, Putnam County was able to purchase upgraded equipment, including 35 new AVL/MDT units with card readers. The units are TRK-240 units by CES Technologies in Orlando, FL. Additionally, Ride Solutions was able to integrate the new AVL system with its proprietary scheduling and dispatch software with the help of Visual Risk Technologies from Nashville. The following paragraphs provide a more detailed description of Putnam County's ITS components.

Computer-Assisted Scheduling – Ride Solution's proprietary scheduling software maintains a client database, as well as information about the general modified service routes. Call takers have the ability to take trip requests and fit them into the scheduled routes. The software automatically generates driver manifests and allows dispatchers to locate addresses on a map in order to give drivers directions when necessary.

AVL/MDT - The AVL/MDT tracking view provides a real time geographical display of vehicle location, direction, and status. In addition to real time information, the AVL/MDT produces a number of management reports:

- The **Vehicle Location Report** allows staff to monitor their vehicle fleet's presence at specific locations. The operations staff can produce a report on each vehicle showing whether they were at a specific location, as well as the duration of their dwell time at the location.
- The **Report View** allows staff to generate a variety of graphical and tabular history reports for any combination or group of specific vehicles.
- The **Vehicle Activity Map** shows a graphical display of collected vehicle data. A "snail trail" shows the path and direction of the vehicle. Underlying data reflects the status, speed, and direction of the vehicle at each reporting point.
- The **Vehicle Activity Report** creates a tabular report of the vehicle start time, end time, time stopped, time moving, addresses visited or stopped at, specific locations visited, speed, etc.

Putnam County's ITS Deployment included the purchase of 35 new AVL/MDT units with card readers.

- The **Driver Logon/Logoff Report** shows when drivers logged onto and off of the system, and is used for payroll records.

Communications - Putnam County was able to use their existing radio system for the MDTs, but have experienced some coverage problems. The radios are effective for a 25-mile radius, but have problems outside of that range. The MDTs do have a "store and forward" feature so that, even if the vehicle is outside of the range, messages will eventually be sent to the dispatcher. The radio system operates in the 800 Mhz band with one repeater and a 400-foot antenna, located on the county's water management tower. Use of the tower has been donated to the operator, so the cost is minimal. Ride Solution has only one channel, but is able to adequately handle both voice and data transmissions. Although the MDTs have text messaging capability, Ride Solution does not often communicate via this method and does not see it as a high priority for future development. However, they have been able to use the MDTs for payroll purposes, vehicle pre-inspection reports, and to send trip manifests to drivers.

Benefits of the ITS Application

The original goal for the ITS project in 1994 was for the system to improve efficiency of the transportation operation. Putnam County staff feel that the technology has accomplished this goal, particularly since the system went from providing primarily demand responsive service to formulating a number of modified service routes. In addition, Ride Solution hoped the technology would facilitate agency billing. This goal has also been accomplished since the software allows the operator to track billing data, thus streamlining the billing process.

Future Enhancements

Overall, Putnam County's ITS components have met their original goals for the project. Ride Solution continues to upgrade their hardware and software, adding more functionality as they see fit. In the future, there are a few specific improvements they would like to implement, including:

- Software to provide a better audit trail for billing purposes by producing invoices.
- The ability to create reports of driver hours in order to facilitate payroll processing.
- They recently installed a 30-item pre-trip checklist for drivers on the MDTs and hope to begin using that function in the near future.
- Optimize the data flow. For example, it currently takes them two hours a day to print out the driver manifests. They would like to reduce the amount of time it takes for this function.
- They plan to install a reservation module in the software.

Other Considerations

Management at Ride Solution indicated that training drivers to use the new system was somewhat difficult. The drivers exhibited "big brother" fears, since the new technology was able to closely monitor their activities. However, once drivers were trained, they adapted well to the technology.

4.7.3 Marion County CTC

Marion County Senior Services (MCSS) was approved for inclusion in the Florida Rural ITS demonstration project in October 1999. At that time, the County had new fixed route services in its small urban center (operated by another entity, SunTran). MCSS's goals for the technology included:

- Improving scheduling efficiency, thereby increasing trip capacity;
- Displaying clusters and patterns of trips;
- Decreasing the two hour pick-up window, improving service to clients;
- Helping in creating modified service routes with deviations;
- Allowing them to interface with the fixed route system and inter-county routes that run into and through Marion County; and
- Assisting with billing and reporting, especially for Medicaid trips.

MCSS would like to establish feeder routes to the Sun Tran fixed route service, but has put this on hold until they can precisely identify rider origins, destinations, clustering and patterning.

Description of the ITS Application

The ITS application in Marion County provides automated scheduling and dispatching functions using the ParaLogic software. Prior to being involved in the project, MCSS used their computers only to take reservations. All scheduling was done manually. Now the ParaLogic software is used to take reservations and schedule trips. The software maintains a client database and saves standing orders that have been optimized and manually formulated into modified service routes by the dispatchers (using the maps generated by the software, as shown in figure 4-7). The system also keeps track of actual passenger trip distances, which are used for billing purposes.

MCSS initially purchased one server, eight workstations, nine monitors, and seven UPS battery back-ups. Additionally, they purchased a larger hub to relieve network "lock ups", and upgraded to a larger modem to accommodate Medicaid billing. In addition to purchasing RouteLogic's software, MCSS also purchased PC Anywhere and ProComm Plus (communication software applications) for remote access by RouteLogic support staff and electronic billing to the Medicaid fiscal agent. Some of the hardware upgrades and software purchases were unexpected costs, and the need for the software to interface with Medicaid was unanticipated. This interface became necessary due to a change in Medicaid billing practices.

Training

Although MCSS staff did receive some training from RouteLogic, the majority of their learning has come from trial-and-error with the software and from peer-to-peer training from Flagler County. Staff spent a couple of days in Flagler County, learning about the ParaLogic software and about Crystal Reports. However, key to the peer-to-peer training was recognizing that their operation was somewhat different than the operation in Flagler County, and figuring out how to translate what they had learned. For example, Flagler County has 80% standing orders, while Marion County only has 40% standing orders. This means that MCSS receives a significantly higher number of calls for trips than Flagler County. Staff needed to keep this in mind when applying their newly acquired knowledge.

Operational Challenges

MCSS has been experiencing some operational issues with the technology and has not been able to fully accomplish a number of important goals. Prior to joining the project, Marion County did not have Y2K compliant computer software or hardware. Also, their employees did not have experience with geo-coding, mapping, GIS, GPS or Windows software. Consequently, MCSS had to absorb considerable overtime costs during the first months of implementation, particularly because the ITS system had to be up and running by January 2000 and funding did not become available until November 1999, resulting in an incredibly small window for implementation.

As of February 2002, the ITS application in Marion County was still experiencing a number of operational problems, including:

- The system would crash if they tried to do other functions while printing driver manifests.
- The Medicaid billing interface was not working correctly.
- Some functions were very slow, which was impacting call intake and scheduling. The scheduling process was taking up to six minutes, so the dispatcher often had to take the reservation on paper and then put it into the system at a later time. Prior to implementing the new software, scheduling could be done in approximately one minute.
- The program did not recognize when a vehicle was full.
- The program did not recognize map geography accurately.
- Driver manifests produced by the software were confusing and difficult to read. Therefore, drivers were color-coding them with highlighters.
- Schedulers were having difficulty changing standing orders, routes, and client addresses once they were in the system. The software did not handle automated batch scheduling as well as the county had hoped it would.

The agency hired an outside consultant to evaluate the technology and recommend corrective measures after they began experiencing problems with the system. The consultant cost was $2,000, and his recommendations resulted in an investment of $4,400 in hardware upgrades. Although the upgrades improved system performance to some degree, MCSS was still experiencing problems with system performance as of February 2002.

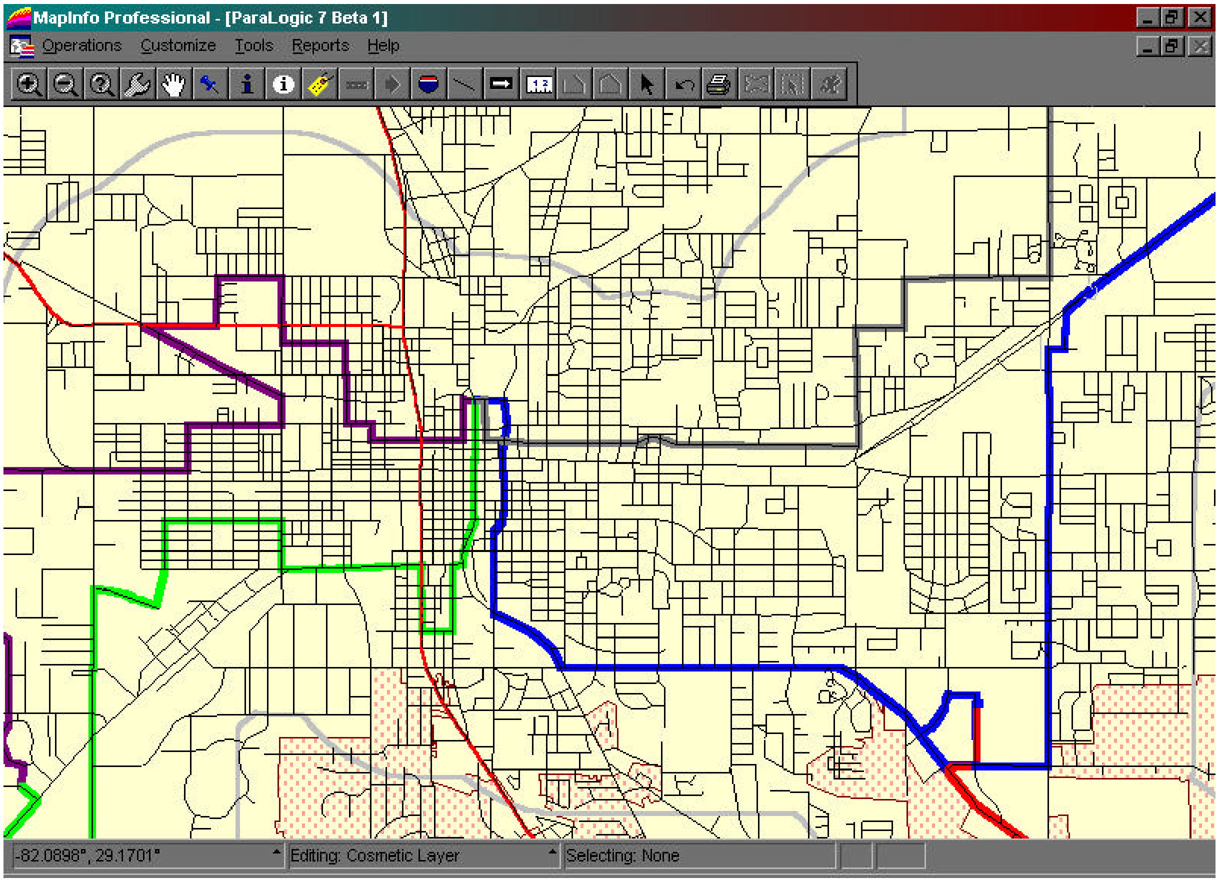


Figure 4-7: Screen Showing Fixed Route and ADA Boundary in Marion County

Benefits of the ITS Application

Although MCSS has had some issues and challenges in implementing the ITS application, they have also realized some benefits from the technology. The managers feel like they have more information available at their fingertips, which allows them to do their jobs with less stress. For example, the software allows them to see an activity report for any route, as shown in figure 4-8. The mapping capabilities of the software have made it much easier for schedulers to schedule trips and service has therefore become more productive. Additionally, reporting is much better with the new system, which helps with billing and in tracking operations.

Other Considerations

Perhaps the biggest issue faced by Marion County was the short timeframe they were given to implement their ITS application. Since funding that was promised in July 1999 only became available in November 1999, MCSS had four months less than anticipated to get the system up and running. The rush to deploy the system was particularly important since the agency's existing systems were not Y2K compliant. In retrospect, managers at MCSS feel that they would have benefited from an incremental start-up with a full acceptance-testing program. Because of the short timeframe for implementation, they did not have time to fully "scrub" the data before the system came on-line. Furthermore, they would have liked to have had more time to train staff on the new system. Managers feel that they were somewhat "naïve" and didn't know which questions they should have been asking during the implementation. Their experience points to the importance of looking at the experiences that other agencies have had with similar implementations and trying to learn from their successes and mistakes. Their experience also points to the value of bringing in technical expertise at the outset of a project.

4.8 Additional Project Considerations

The previous sections have highlighted a number of important considerations for agencies considering Rural ITS implementations. The following sections describe additional considerations.

4.8.1 The Planning Process

The CTCs agreed that the operational studies were useful, independent of the technological components. The analysis helped them look carefully at their systems and see what they were doing well versus what they could improve upon. Additionally, the CTD required that the software vendor provide an explanation of the needs for data "scrubbing" and conversion, minimum hardware specifications, and training plans for the various CTCs. Case studies at other agencies have highlighted the importance of doing comprehensive needs assessment and planning prior to procurement and implementation. The successes experienced by many of the Florida demonstration project participants support the importance of pre-deployment planning.

Agencies should also keep in mind that, for all practical purposes, there is no such thing as "off-the-shelf" software. Even when purchased for a single paratransit operation, significant customization is needed to provide the functionality required by the end user. This point is all the more salient when multiple agencies are slated to get the same basic software package. In Florida, each of the CTCs had different needs and planned to use the software to a different degree. For example, in Flagler County, where standing orders comprise 80% of trips, the software dealt well with scheduling demand responsive trips. However, Marion County has only 40% standing orders and therefore schedules a much larger number of demand responsive trips on a daily basis. Whereas Flagler County has had no problem with the software's performance, Marion County continues to experience operational difficulties.

4.8.2 The Installation Process

One notable practice in Florida is the way in which upgrades and enhancements are made to the ParaLogic system. When a customer requests an enhancement, RouteLogic develops a beta version of the software that includes the enhancement. The beta version is sent to the participant who requested the change, and this participant in turn spends time testing and assessing the new feature. Once the beta version has been adequately tested, it is sent to the remaining participants. This practice minimizes disruption to the CTCs by not having them install versions with beta features that are not ready for release. Additionally, upgrades to the software can be easily installed at the various agencies since they can be done using remote access software.

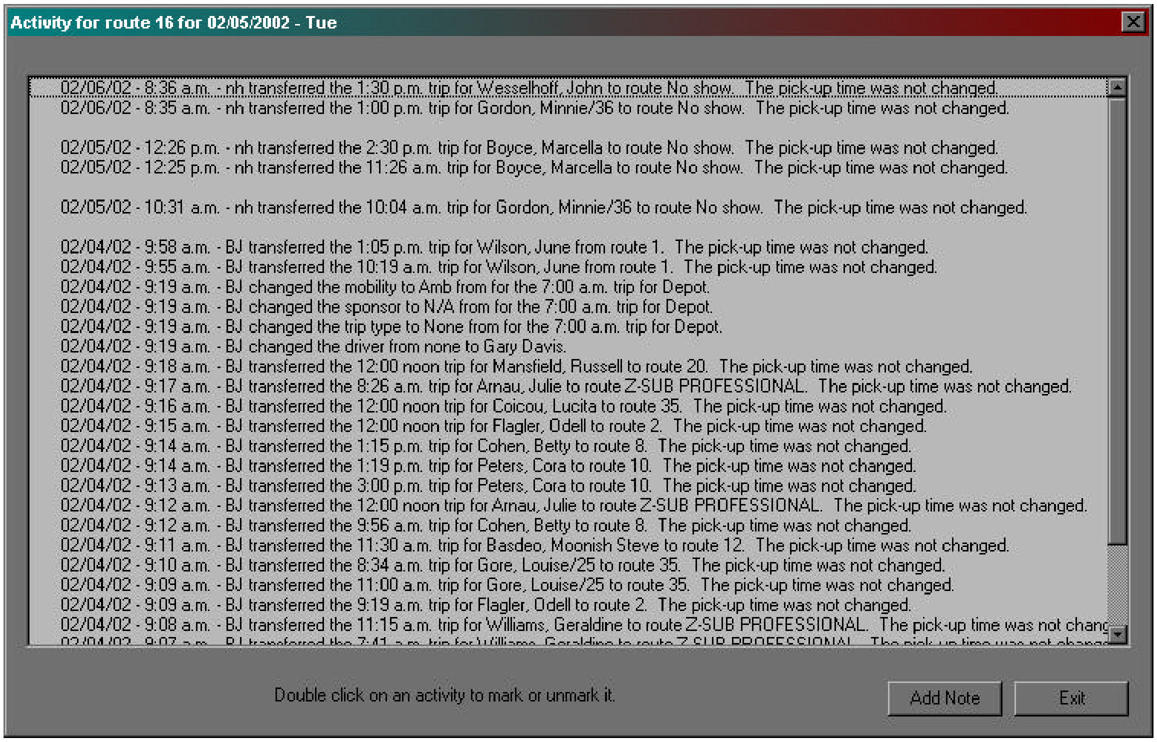


Figure 4-8: Activity Report Generated by ParaLogic

4.8.3 Other Considerations

From the start, the CTD emphasized the importance of evaluating the on-going success of the ITS deployment to make sure it was meeting participants' goals. At the end of Phase 1, CUTR was commissioned to do a quantitative evaluation of the project for the State. The Northeastern Florida Regional Planning Council (NEFRPC) was hired to do data collection and, together, the three Phase 1 participants, the CTD, and the researchers settled on a number of measures that would be used to evaluate the project. While the analysis showed that the project had not increased inter-county coordination as much as the participants initially had hoped, it did help the participants realize that there were other dynamics within the project that required attention and that success should not be measured solely by the increase in inter-county trips. When federal evaluators began looking at the project, they not only conducted quantitative analysis, but also spent time interviewing staff at each of the participant systems. Through this process, participants recognized a number of other project benefits, which ultimately served to give them a better sense of accomplishment and purpose.

Another point that came across strongly in the Florida case study was the importance of peer-to-peer training in the success of the project. While the vendors provided training, the participants felt that they learned the most from their peers who had already implemented the system components. Not only is this type of training effective, but it can also serve to minimize the costs of project implementation by reducing the amount of vendor training required.

4.8.4 Unexpected Benefits

The Florida Rural ITS Demonstration project has resulted in a number of unexpected benefits, as follows:

- Local agency staff have increased their skill level and developed technically and professionally by learning the new technologies;
- The operational studies provided assistance to the CTCs in all management areas, not just technology. In fact, it's difficult to separate ITS success from other organizational changes. ITS helped to "prime the pump," but improvements often came from new ideas and management practices;
- Participants developed increased self-confidence through education and exposure to technology, making them more open to new technology-based approaches to doing business;
- The technology improved employee performance and value; and
- The project increased peer-to-peer cooperation through successful support and training from neighboring agencies. The new coordination has built strong relationships between funding agencies, funding recipients and vendors.

4.9 CTD Future Plans

CTD feels that there are opportunities for the ITS project to grow through use of the GIS applications. They hope to use the technology to analyze travel patterns, which will allow them to further regionalize transportation services and promote even better coordination among the CTCs. Additionally, the CTD plans to develop fixed-route overlays for the GIS applications so that opportunities for coordination between service provided by the CTCs and fixed route services can be more easily identified.

The CTD also plans to expand the trip types included in the project, as well as agency participation. The third project phase will expand the program to Union County. Union County provides approximately 60 trips per day and currently has no computers or technology. One of the key issues in Phase 3 will be related to converting client, schedule, vehicle, and other data from legacy systems to ParaLogic. The CTD realizes that data conversion is not only costly but requires significant data manipulation. Additionally, training is expected to be very important in Phase 3 and the CTD hopes to rely heavily on the peer-to-peer training method it has already started developing in Phase 2.

5.1 Case Study Overview

In 2000, spurred by welfare reform and the corresponding need to better manage transportation being provided to welfare clients, the ATRI at the University of New Mexico began to develop a Web-based software application to coordinate rural transportation funding. The Client Referral, Ridership, and Financial Tracking (CRRAFT) system is an interagency effort that includes the New Mexico Department of Labor, the New Mexico Human Services Department, the New Mexico State Highway and Transportation Department's Public Transportation Programs Bureau (PTPB), and rural transit service providers.

The project has three major components and a number of unique features. Part 1 involved developing a Web-based software program to certify and schedule trips, track riders, bill trips, and generate reports. After considering a variety of off-the-shelf products, ATRI and PTPB decided to build their own Web-based application. The project was designed to address the diversity and spatial distribution of transit systems by having a single application reside on a server which is accessible to agency users over the Internet. ATRI believes that the Web-based design will save costs and time of installing, troubleshooting, and upgrading software. Part 2 of the project involves establishing the Internet connections between the CRRAFT server and the rural agencies so they can access trip information, do billing, and produce reports without having the CRRAFT system installed locally. At the time of the site visit, the Beta testing phase had been completed and ATRI has performed initial training at two rural transit systems. Once the system is implemented at all 26 of the transit systems, ATRI estimates that approximately 150 vehicles will be tracked and between 3,000 and 5,000 clients will be included in the system.[11] Part 3 is procurement of a multipurpose electronic farecard system and in-vehicle card readers that will be integrated with the CRRAFT system. The farecard will use the state's current electronic benefits transfer (EBT) card to issue transportation privileges to human services clients. Infrequent general public riders will also be able to buy disposable, magnetic stripe passes that can be used on the transit vehicles, while frequent general public riders will have access to a card similar to the EBT card.

Monitoring of transportation providers by state agencies is often viewed as a difficult task in the transit community. Development of the CRRAFT system provides a model of how agencies can use technological solutions to help improve the coordination between funding agencies and their subgrantees. The application itself has sparked the interest of the FTA/FHWA Joint Programs Office (JPO), which has provided funds for CRRAFT development and training efforts. The JPO hopes to use the system as a national showcase for this type of rural transit ITS application.

[11] The system will also track an unknown number of general public riders.

ATRI Case Study Field Work

In order to learn about the CRRAFT system, the research team conducted a site visit on May 8 and 9, 2002. The site visit was coordinated with ATRI staff and included a visit to one of the transit system locations (Los Lunas). During the site visit, the team interviewed the following ATRI staff:

- Judith Espinosa, Director;
- Matthew Baca, Transportation Research Programs Manager;
- Nancy Bennett, Program Manager;
- Mary White, Program Coordinator; and
- Jack Valencia, Consultant, TransCom.[12]

Additionally, the team spoke with the following transportation administrators:

- Pearl Lucero, Transportation Manager, Village of Los Lunas;
- Shereen Snare, Administrator, Village of Los Lunas; and
- Larry Alflen, Director, Zuni Entrepreneurial Enterprises.

5.2 Project/System Background and History

The New Mexico State Highway and Transportation Department (NMSHTD) and its Public Transportation Programs Bureau (PTPB) have long recognized the importance of transportation in maintaining the State's economic well-being and the quality of life for its residents. When welfare reform occurred at the national level, the PTPB began to investigate transportation barriers affecting New Mexico's Temporary Assistance for Needy Families (TANF) recipients. In November 1998, the PTPB contracted with ATRI to produce a report entitled *Public Transportation: A Priority Link in Moving People to Work*. The study found the lack of adequate transportation to be one of the greatest barriers impeding people's transition from Welfare to Work (WtW). This study led to a more comprehensive effort titled *Moving Forward: A Transportation Toolkit for Welfare Reform,* which was funded by the New Mexico Human Services Department (HSD), Income Support Division (ISD). The *Toolkit* underscored three important points:

- Many governmental departments and agencies provide assistance to the same populations of individuals;
- The lack of transportation often prohibits people from accessing programs which could lead to economic self-sufficiency; and
- No matter how great the opportunity or how well-designed the assistance program, if people do not have reliable and affordable transportation to get to their destinations, these opportunities and programs might as well not exist.[13]

[12] Jack Valencia is a consultant who has worked continuously with ATRI in implementing the CRRAFT system.

The *Toolkit* helped to show that coordination between different agencies and programs could be beneficial to both the transportation-disadvantaged persons they were trying to serve and the agencies themselves. Eventually, the *Toolkit* became the statewide strategic Job Access Reverse Commute (JARC) plan for New Mexico. The document recommended that the State, community transit providers, and Tribal departments and agencies work toward developing a coordinated transportation system.

However, the agencies involved recognized that coordination would be challenging, particularly given the large size of New Mexico, the high poverty levels, and the low population densities. The most significant barriers to coordination identified included the following:

- Agencies were reluctant to coordinate transportation because they feared their funds would pay for the transportation of other agency's clients. Thus, they needed assurance that their transportation funds would be used only for their own clients.
- The different funding agencies (NMHSD, NMDOL, and FTA JARC) had varying reporting requirements, which caused a great deal of administrative difficulties for the rural transportation providers. In order to provide coordinated services, the differences in these reporting requirements had to somehow be resolved.
- The funding agencies wanted to standardize client referral, ridership, and financial information, but were not sure how to do this in the most efficient manner.

Recognizing that these barriers to coordination were significant, ATRI and its partnering agencies began looking for a technological solution to help with the coordination process. They looked at a number of commercial, off-the-shelf products, ranging in cost from $18,000 to $30,000. Many of these software products would require a yearly maintenance fee. After considering and eliminating several of these products, they decided to develop a software package in-house that would standardize transportation referral for clients of various agencies, authorize and track client trips, and report trip costs to funding agencies. They felt that they would be able to develop a product that was more suitable to their environment at a lower cost. Consequently, with funds provided by the PTPB, ATRI began development of its Web-based software program, CRRAFT.

During 2001, ATRI was faced with a reduction in funding for some of its transportation projects. However, because CRRAFT was viewed as an important project that could not be delayed, the Institute continued work on it by providing their own funding. At the same time, they decided to apply for federal funding and were successful in obtaining funding from the ITS JPO. ATRI's first conference call with the FTA occurred in December of 2001,

Los Lunas was one of the two transit systems included in the first phase of CRRAFT installation.

[13] Moving Forward: A Transportation Toolkit for Welfare Reform, ATR Institute, April 2001.

and the final contract was signed in January 2002. The agreement will provide ATRI with $300,000 over the next 2 years for additional development of CRRAFT and for training the end-users of the system (i.e., the transit systems). In exchange for the funding provided, the JPO hopes to use the CRRAFT system as a showcase for other areas across the country.

Beta testing for the CRRAFT system by five transit systems began in July 2001 and was slated to last 30 days. However, the workloads of staff at the transit systems kept them from having adequate time to test CRRAFT and, consequently, the Beta testing phase was extended to 90 days.

In January 2002, ATRI decided to work with two primary test users to ascertain which was the "best fit" for a more directed field test. The Village of Los Lunas was selected for the following reasons:

- The Director was interested in pioneering the software;
- Los Lunas is within 30 minutes driving time of Albuquerque, where ATRI is located;
- The Village planned to provide the transit system with new computers in April 2002;
- Internet speeds were acceptable at the transit system;
- Los Lunas Transit is both a Section 5311 and 3037[14] subgrantee; and
- Los Lunas Transit has a good working relationship with Su Parte, the TANF contractor for the New Mexico Human Services Department in Valencia County.[15]

Additionally, ATRI decided to include the Zuni Reservation as one of the first test users for the CRRAFT system. At the time of the Rural ITS site visit, ATRI had just made the CRRAFT system available to staff in Los Lunas and on the Zuni Reservation.

ATRI selected a contractor to provide the EBT card readers in 2001. According to ATRI, five vendors responded to their Request for Information (RFI) for the system and two other Requests for Proposals (RFPs). Their selection was based on a number of factors including cost and the background/experience of the bidding firms.

5.3 Project Goals and Objectives

5.3.1 Stakeholders

The CRRAFT project is a multi-organizational effort that requires a great deal of coordination and cooperation between the parties involved. Although a detailed description of the project participants was not necessary in the other case studies, it is included here because it contributes to understanding of

[14] Section 5311 funds capital, administrative, and operating expenses incurred in the provision of rural public transportation. Section 3037, the Job Access and Reverse Commute Program (JARC), has two primary goals. The first is to help agencies provide transportation services in urban, suburban, and rural areas to assist welfare recipients and other low-income individuals in accessing employment opportunities. The second is to increase collaboration among the regional transportation providers, human service agencies, and related service providers, employers, metropolitan planning organizations, the state, and affected communities and individuals.

[15] CRRAFT Workplan submitted to the FTA/FHWA ITS JPO by ATRI, March 2002.

the project. Funding is being provided at both the Federal and State level, and also may be provided by other governmental entities in the future (such as the Navajo Nation). Currently, key players at the Federal, State and local levels involved in the CRRAFT project are:

- The PTPB;
- The ATRI;
- A number of rural transportation providers, most of which are members of the New Mexico Passenger Transportation Association (NMPTA);
- The New Mexico HSD, ISD;
- The New Mexico Department of Labor (NMDOL);
- The Federal Transit Administration (FTA); and
- The ITS JPO, which is providing funding for the CRRAFT project.

The following sections briefly describe the State and local participants in the CRRAFT project.

The Public Transportation Programs Bureau (PTPB)

The PTPB is a bureau in the NMSHTD that oversees the state's FTA Section 5310, 5311, and 3037 programs. Section 5310 funds capital acquisitions for transportation services designed to meet the mobility needs of elderly and disabled persons. Section 5311 funds capital, administrative, and operating expenses incurred in the provision of rural public transportation. Section 3037, the Job Access and Reverse Commute Program (JARC) "assists states and localities in developing new or expanded transportation services that connect welfare recipients and other low income persons to jobs and other employment related services. Job Access projects are targeted at developing new or expanded transportation services such as shuttles, vanpools, new bus routes, connector services to mass transit, and guaranteed ride home programs for welfare recipients and low income persons. Reverse Commute projects provide transportation services to suburban employment centers from urban, rural and other suburban locations for all populations."[16]

The PTPB's overall responsibility is to "administer grants and subgrants, select subrecipients and projects, comply with Federal requirements, and ensure that all subrecipients comply with Federal requirements."[17] Both the NMHSD and the NMDOL have agreed that the PTPB should be the lead agency in eliminating transportation barriers of people moving from welfare to work. Because JARC grants require a local match, the PTPB leverages funds from the NMHSD and the NMDOL with those from FTA JARC grants in rural New Mexico. The PTPB has been at the forefront of transportation coordination in the State of New Mexico, and has provided significant levels of funding for ATRI to study possible coordination opportunities. Likewise, the agency has provided support and funding for

[16] Federal Transit Administration Website: http://www.fta.dot.gov/wtw/jarcgfs.htm

[17] New Mexico State Highway and Transportation Department Web site: http://www.nmhstd.state.nm.us/

development and deployment of the CRRAFT system, particularly since the PTPB will act as the state administrator for the system.

The PTPB also serves as the state-level pass through for Section 5307 funds (urban system) for the City of Santa Fe and the City of Las Cruces. While the City of Santa Fe has expressed interest in participating in the CRRAFT system, the PTPB has no authority to require their participation. Nonetheless, the PTPB may choose to accommodate them at a later date if it deems this possible.

The Alliance for Transportation Research Institute (ATRI)

ATRI at the University of New Mexico "creates realistic, workable solutions in transportation that address current needs while anticipating future demand. The ATR Institute develops strategies with a constant eye to practicality. Its work ranges from applied to conceptual knowledge developed for a very real world."[18] ATRI has "become the nexus for transportation coordination activities between New Mexico human services and transit agencies. Institute staff have specialized in filling the niche created when federal welfare reform, Welfare to Work, and transportation act reauthorization occurred from 1996-1998."[19]

The CRRAFT system was the result of ATRI's realization (and PTPB's agreement) that effective transportation coordination would require a technological solution in the State of New Mexico. With both financial support and functional input from the PTPB, ATRI has taken the lead in developing, deploying, and maintaining the CRRAFT system. Recently, ATRI also acquired additional support from the JPO to continue to support CRRAFT.

Rural Transportation Providers

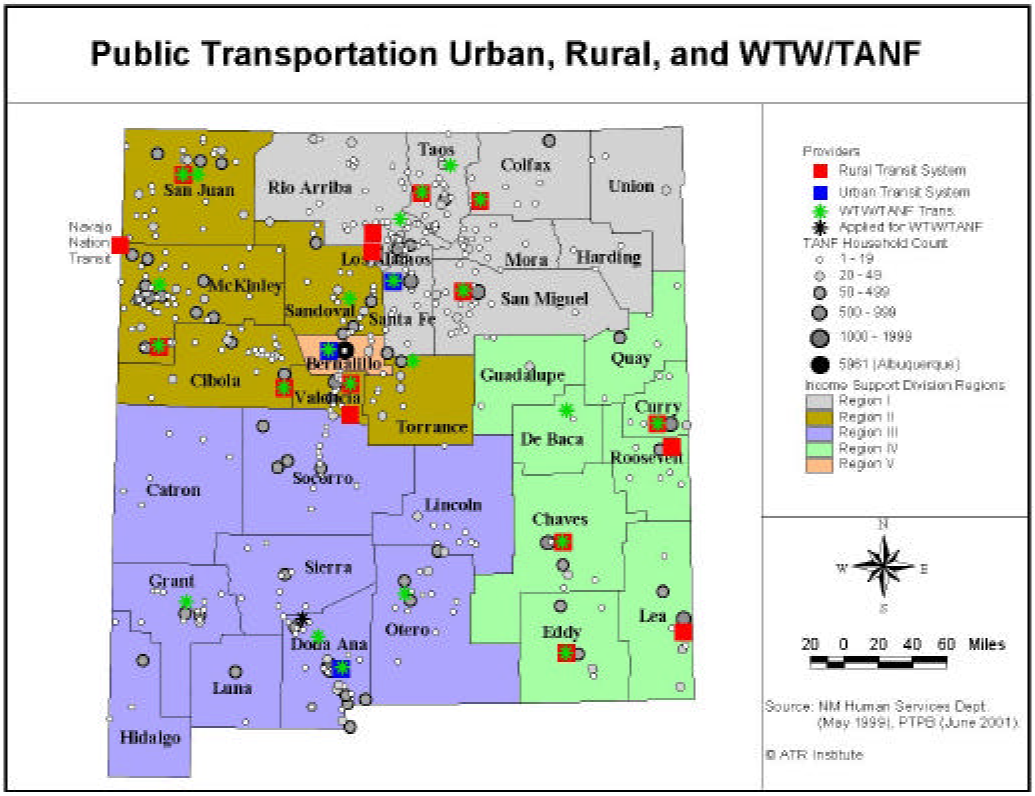
Currently, there are 20 rural transit providers in New Mexico and 3 urban transit providers, as shown in figure 5-1. Most of these transportation providers receive both 5311 and 3037 funds (only a few receive *only* 3037 funds, and a couple receive 5311 funds but not 3037 funds). Ultimately, all transportation providers that receive JARC, WtW, and/or TANF funding will be required to use the CRRAFT system. The transportation providers are spread throughout the State, which covers an area larger than all of the New England states combined, as seen in figure 5-2. The fact that New Mexico's rural transportation providers are so spread out across the State had significant implications for the design of the CRRAFT system.

Most of the rural transportation providers belong to a group called the New Mexico Passenger Transportation Association (NMPTA). The NMPTA is a "nonprofit association comprised of (sic) individuals, organizations, rural transit providers, and transportation vendors whose function is to advance public transit in rural New Mexico."[20] Administrative and executive functions of the NMPTA are funded by New Mexico's Rural Transit Assistance Program (RTAP), which provides training and

[18] From the ATRI Mission Statement

[19] CRRAFT Workplan submitted to the JPO

[20] "Public Transportation: A Priority Link in Moving People to Work", prepared by the ATR Institute, October 1998.



technical sessions on various regulations affecting rural transit providers. With the implementation of CRRAFT, the coordination and collaboration

Figure 5-1: New Mexico Urban and Rural Transit Systems

Source: Alliance for Transportation Research Institute

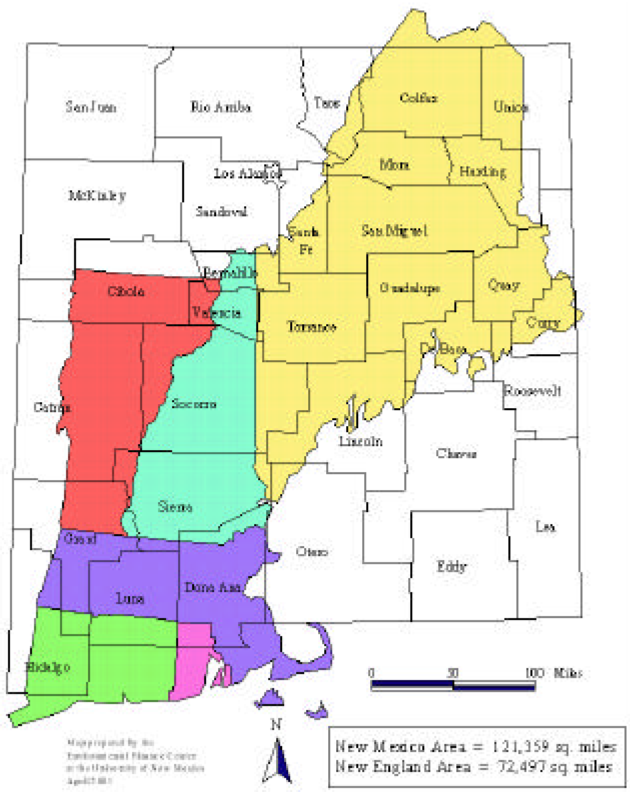


Figure 5-2: Relative Size of New Mexico Compared to New England

Source: Alliance for Transportation Research Institute

among the rural transit providers (and between the providers and their funding agencies) will hopefully be increased to an even higher level.

<u>The New Mexico Human Services Department (NMHSD)</u>

In August 1996, the United States underwent one of the most significant welfare reforms in history when the Personal Responsibility and Work Opportunity Reconciliation Act (PRWORA) was enacted into law. The act eliminated Aid to Families with Dependent Children (AFDC) and created Temporary Assistance for Needy Families (TANF). The TANF program is overseen by the U.S. Department of Health and Human Services (DHHS). Under TANF, States, territories, and Native American tribes receive block grants that are used to cover benefits, administrative expenses, and services targeted to needy families. States may use TANF funds to develop and fund new approaches for serving clients' transportation needs.

In New Mexico, NMHSD oversees the TANF Program, entitled New Mexico Works. Services to clients under this program are provided by five contractors: the University of New Mexico, Highlands University, San Juan College, New Mexico State University, and Western New Mexico University. These contractors have the responsibility of determining whether clients are eligible for transportation assistance under the New Mexico Works program and providing referrals to the relevant transportation agencies. Direct funding for transportation from NMHSD is funneled through the PTPB, which distributes funding to the corresponding transportation providers.

Both the NMHSD and the NMDOL (described below) have been very supportive of PTPB's efforts to coordinate human services transportation in New Mexico and to develop the CRRAFT system. The software will benefit these agencies in a number of ways, including automating the transportation referral process, tracking revenue streams, tracking use of public transportation by their clients, and improving information flow.

The New Mexico Department of Labor (NMDOL)

WtW, which is overseen by the U.S. Department of Labor, was created under the Balanced Budget Act of 1997. Most WtW clients are a subset of TANF recipients. According to the Department of Labor:

> "Welfare-to-Work (WtW) grants to States and local communities are intended to help hard-to-employ welfare recipients move into lasting, unsubsidized jobs. The grants are used to equip long-term welfare recipients and noncustodial parents – generally those with poor education, low skills, and little job experience – with the resources and support they need to keep good jobs. Local communities have the flexibility to design programs that fit their particular needs."[21]

In New Mexico, the NMDOL administers the State WtW Program. WtW funds may be used for job retention and supportive services such as transportation. The NMDOL contributes funds for the provision of transportation through the PTPB.

5.3.2 Goals and Objectives

In general, human service agencies and transportation providers tend to have very different organizational cultures, which can sometimes make it challenging for them to work together. For example, human services agencies are usually case-centered, while transit providers are typically trip-centered. Human service agencies measure their success by the number of clients served or reductions in case loads, while transportation providers measure success using performance measures such as the number of trips provided, cost per trip, or cost per vehicle-hour. Therefore, the type of information needed by these two groups is very different.

Human services departments ask questions such as:

- How many TANF clients were served?
- Where did the clients go?
- How much did the trips cost our agency?

At the same time, transportation agencies are asking different types of questions, such as:

- How many trips did we provide?
- How many vehicle-miles were traveled?
- How many fares were paid and how many were billed to TANF?

[21] U.S. Department of Labor, Welfare-to-Work Web site: http://wtw.doleta.gov/

- What was the cost per trip?

One of the primary purposes of CRRAFT is to bridge the differences between these two types of organizations by providing both types of information with one system. Thus, one of the PTPB's primary goals in encouraging development of the CRRAFT system was to standardize the data and information provided by transportation providers to their funding agencies.

On the funding agency side, the CRRAFT system will benefit the sponsoring agencies by helping them generate financial and client tracking reports. Additionally, CRRAFT will generate FTA Sections 5311, 5310, and 3037 reports, thereby helping the State agencies with their reporting requirements for Federal transportation funding. Additionally, CRRAFT will standardize client transportation referrals and may reduce the abuse of transportation assistance. By standardizing the reports provided by the various transit systems, the CRRAFT system will make it easier for the agencies to track usage of transportation benefits by their clients. Once ATRI enhances the existing import and export capabilities of the software, agencies will be able to manipulate data more easily since the data format will be standardized.

For the transit operators, CRRAFT will simplify ridership reporting and invoicing. Interestingly, ATRI mentioned that one of the problems they faced in the Beta testing phase of the project was that many of the transportation providers did not have time to test the system. They were spending so much time on reporting and invoicing that they found it difficult to spend time trying out the CRRAFT software. By simplifying and centralizing the reporting function, ATRI hopes that the CRRAFT system will result in significant timesavings for the transit systems. CRRAFT may also increase the transit systems' efficiency by helping them more easily schedule trips and track maintenance, among other functions.

In the words of ATRI:

> New Mexico is challenged to make sparse State and Federal dollars go as far as possible. The more agencies that participate in CRRAFT and piggyback their client identification with the EBT/Transit Card, the lower the overall cost per program. Through coordination and appropriate use of technology, agencies and departments can create partnerships that remove transportation barriers, leverage scarce resources, and better serve communities. Providing a systematic approach to addressing the lack of transportation options for the underserved will help expand opportunity, help strengthen the State's economy, and help create a healthier future for all New Mexicans.[22]

5.4 Description of the Application and Technology

5.4.1 The CRRAFT Software

Figure 5-3 shows a general overview of the CRRAFT system and the following paragraphs provide a description of how CRRAFT functions. An individual applying for public assistance first contacts the

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[22] CRRAFT Workplan submitted to the FTA/FHWA ITS JPO by ATRI, March 2002.

NMHSD/ISD office. If the applicant is approved for public assistance, an appointment is made with the appropriate New Mexico Works contractor, who then certifies (or re-certifies) the individual as TANF, WtW or JARC. Individuals who are certified as eligible for TANF or WtW are typically eligible for assistance under JARC as well. Once the individual has been certified for a specific program, the case worker assesses the client’s available transportation resources and needs. If the client has sufficient resources, he/she is not given transportation assistance. If the client does require transportation assistance, the case worker identifies the type of transportation assistance that best fits the client's needs. In some cases, public transportation may not be available or other forms of transportation assistance may be more appropriate. If the chosen means of transportation is public transit, the client is given transportation privileges on his/her EBT card and the case worker provides a referral to a transportation provider. The case worker (as well as the funding agencies) will be able to access client information via the screen shown in figure 5-4.

Currently, referrals are being completed manually on the form shown in figure 5-5 and then faxed by the case manager directly to the transportation providers. However, in the future, caseworkers will enter data directly into CRRAFT’s central database, which will then inform the transit system that they have been given a new client. With either method, the caseworker is responsible for providing the client with the transit provider’s contact information so that transportation can be arranged. The case worker also has the option of providing other types of transportation assistance, such as money for car repairs or gas vouchers, in which case the client would not be entered into the CRRAFT system.

Once the referral information is in the database, the transportation provider can log into CRRAFT to obtain the client information by name or EBT number. Clients may be eligible for either demand responsive service or a subsidized bus pass for fixed route service, or both. With

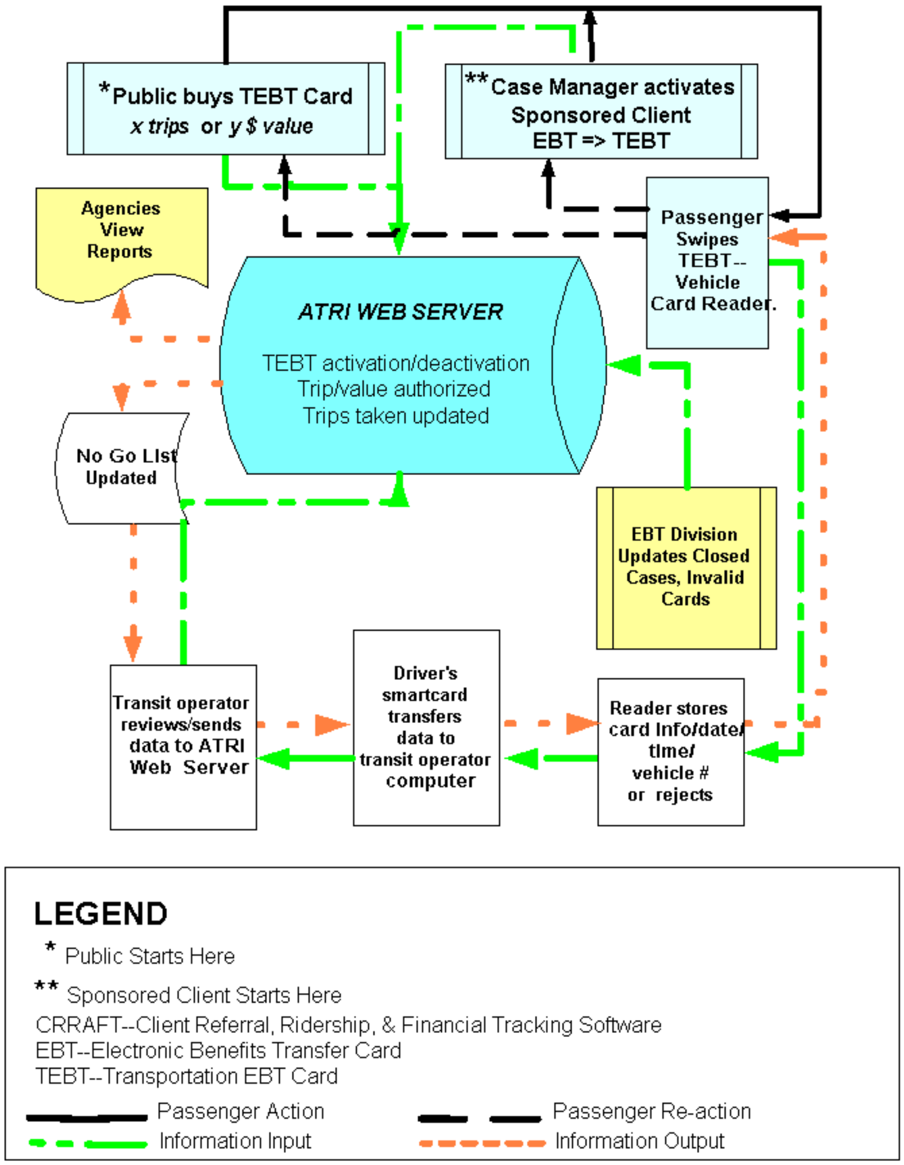


Figure 5-3: Diagram of the CRRAFT System

demand responsive service, a client will call the transportation provider to schedule a trip. The trip request is entered into the CRRAFT system and the provider schedules the trip. Currently, the CRRAFT system does not include a scheduling module, although it does help with this function by allowing trip requests and vehicle availability to be entered into the system. The transportation provider then must manually schedule the trips.

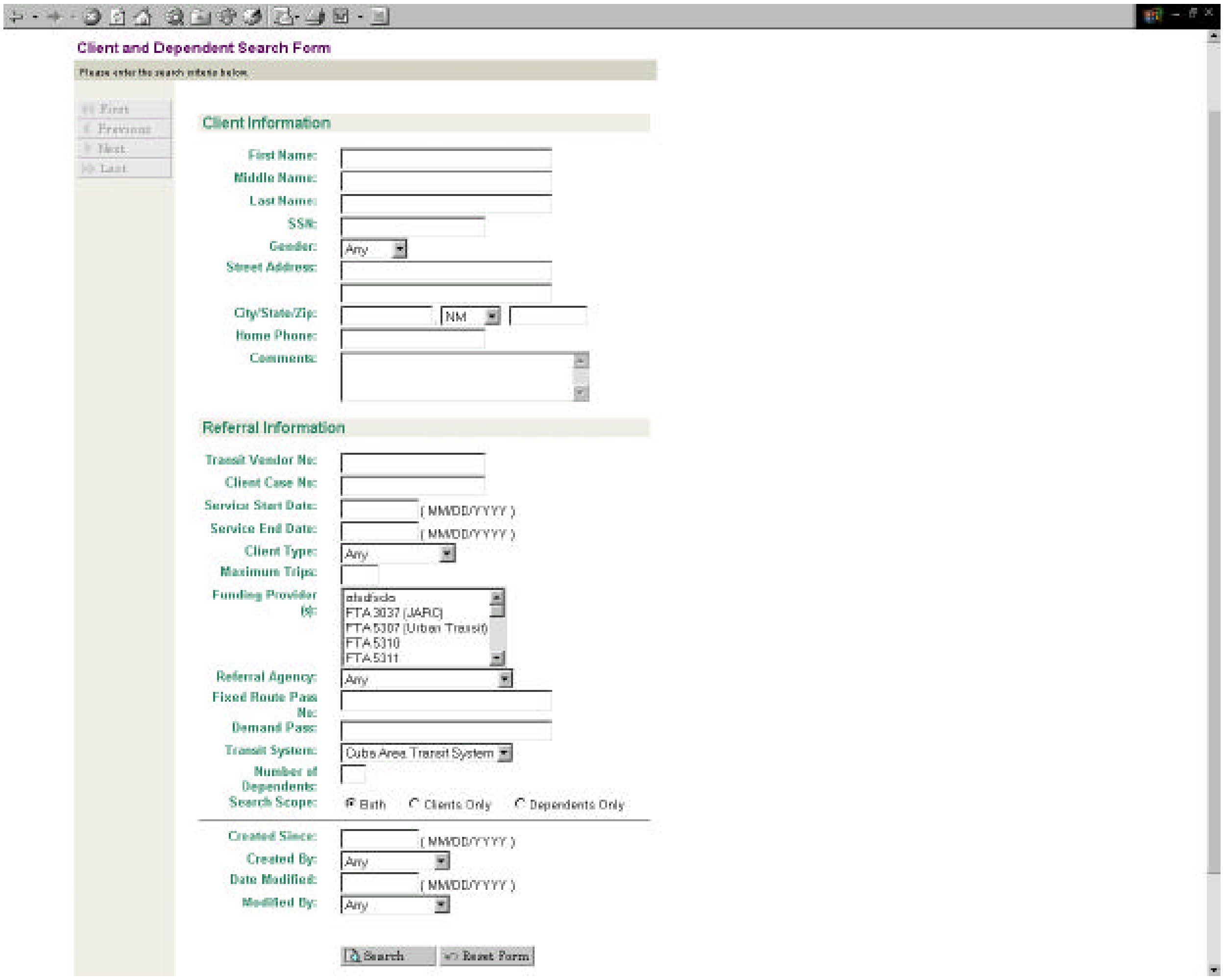


Figure 5-4: Client Information Page in CRRAFT

When the trip is made, the client will either scan his/her EBT card or show it to the driver. Until the automatic card readers are installed on the vehicles, this function will be done manually. Drivers will be required to record the card information, which will then be entered into the CRRAFT system at the end of the day. Once the card readers are installed and functional, they will record the client's card information, which will be downloaded to the CRRAFT system daily. The CRRAFT system will then update the client's information and calculate the number of trips available for each client. For clients who receive transportation funding from multiple agencies, the software will allocate the funds based upon the number of trips taken and the trip purpose. The method for dealing with fixed route trips is similar to that described for demand response trips, except no scheduling is required by the client or provider since the client just catches the bus as needed.

Public Transportation Programs Bureau Transportation Referral Form

Program

❑ Check here if reauthorization

Client Case #

Transit Pass #

Client Name

First MI Last

❑ Male

❑ Female

Street Address ______________________________

Town State Zip County

Nearest Cross Streets (if applicable) ______________ Telephone ______________

Number of Dependent Children Eligible for Transportation

Special Needs ______________________________

(Explain if client needs wheelchair, bus lift, personal service animal, etc. Use other sheets if necessary)

Transportation Provider Telephone

(Name of Transit Provider to which client is referred)

Authorization Period (follow dates in Works Participant Agreement)

Start Date: _____/_____/_____ **End Date**: _____/_____/_____

Mo. Day Yr. Mo. Day Yr.

Destinations	**Location**	**Number of Trips Authorized**
❑ Work		
❑ Education/Training	______________	______________
❑ Job Search	______________	______________
	(list towns)	
❑ Childcare		
❑ Other		
	Total Number of Trips	______________

Funding Program (check only one)

❑ TANF

❑ WTW

❑ Navajo Nation TANF

❑ Native Employment Works

❑ JARC

❑ Special

Authorized by

Signature

Print Name

Date

NM State Highway and Transportation Dept. PTPB TRF1 0201

Figure 5-5: Paper-based PTPB Client Referral Form

Each transit system will have the ability to print out reports, and the funding agencies will be able to log into CRRAFT and access information about the clients they are funding. Figure 5-6 shows the reports that can currently be provided by CRRAFT, and figures 5-7 and 5-8 show two sample reports that might be available to transit systems or administrators. Therefore, the CRRAFT system will dramatically improve the reporting system that is currently in place. Transportation providers will spend less time generating reports for their funding agencies since the CRRAFT system will synthesize all of the relevant information into standardized report formats. Similarly, the funding agencies will be able to access information in a timely manner and the information will be in a consistent format.

The CRRAFT system offers a number of useful functions at both the state administrator and transit system level. Figure 5-9 shows the five modules in the CRRAFT system that are available to administrators, while figure 5-10 shows the more limited number of modules that are available to transit systems. It is important to note that many of the modules shown in the two figures are dependent on one another. For example, a vehicle cannot be assigned without a driver. Therefore, the modules do not operate independently - some modules depend on or support others.

Access to the CRRAFT system will be carefully controlled. CRRAFT users will access the software with the use of a password. In order to make the system more user-friendly, ATRI has, at the request of the transit systems, implemented an 8-hour window in which a user can have access to the system without re-logging in. Each user's access will be defined by their job duties and will be determined by the administrator at each location and by ATRI. In fact, ATRI has the ability to control access at three different levels: the module level, the function level, and the field level.

For example, a transit driver may be allowed to record mileage and number of trips provided. The mechanic may have access to the vehicle records and maintenance. The transit dispatcher may be able look at trip requests and vehicle utilization in order to schedule client trips on a given vehicle for a given time and date. The administrator at each transit system will likely have access to client records and financial information. Case managers from referring human service agencies will be able to access only the client referral form. State-level departments will have read-only access to their clients' data. For example, they may review trips authorized, trips taken, and costs.

While the CRRAFT system will be used primarily for demand responsive transportation service, it has been designed to also handle fixed route services. The ability to handle these types of services is important since some systems, such as the one in Zuni, do have fixed routes.

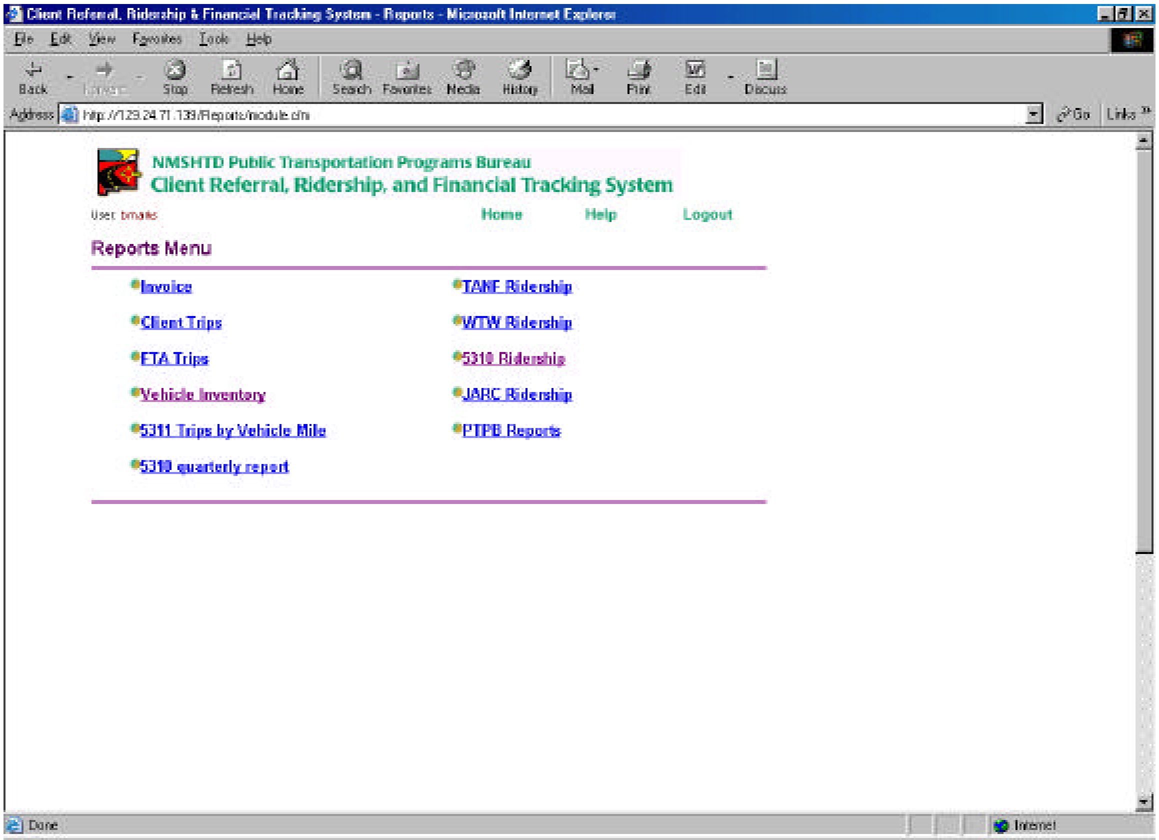


Figure 5-6: Reports Available in the CRRAFT System

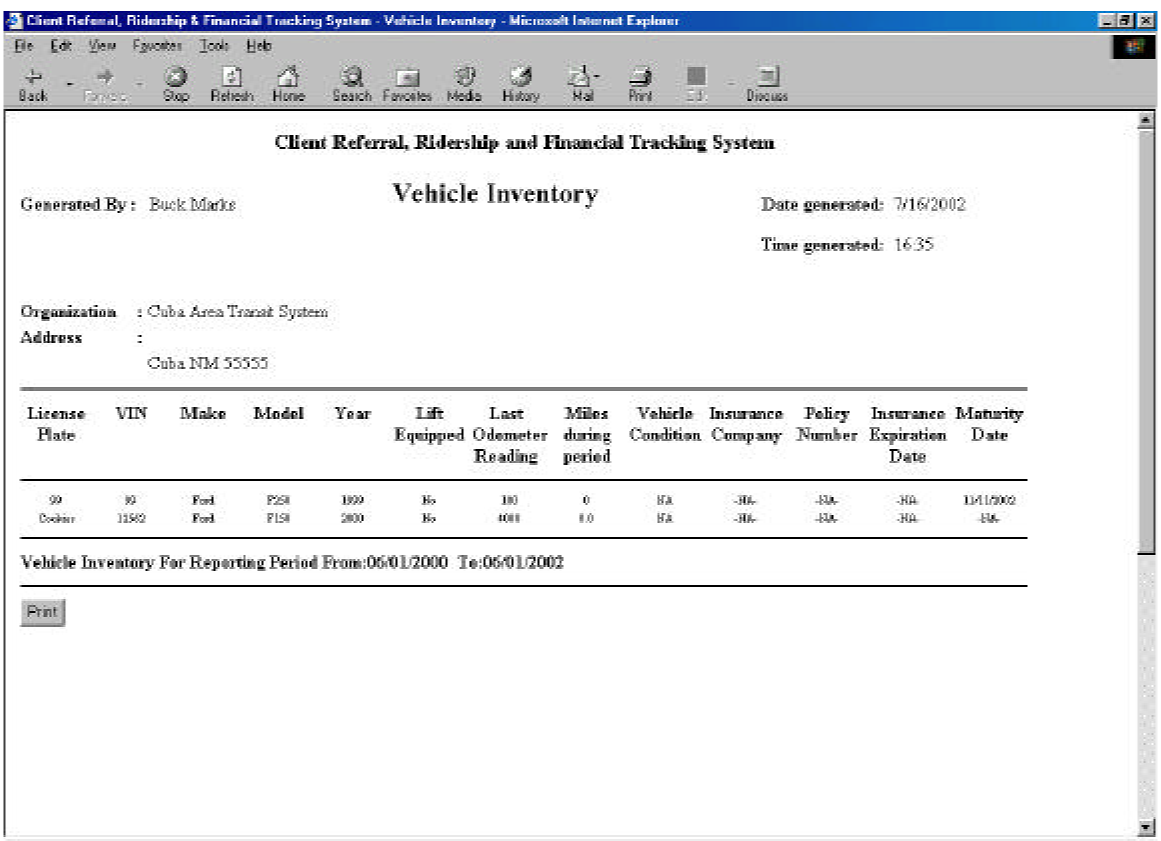
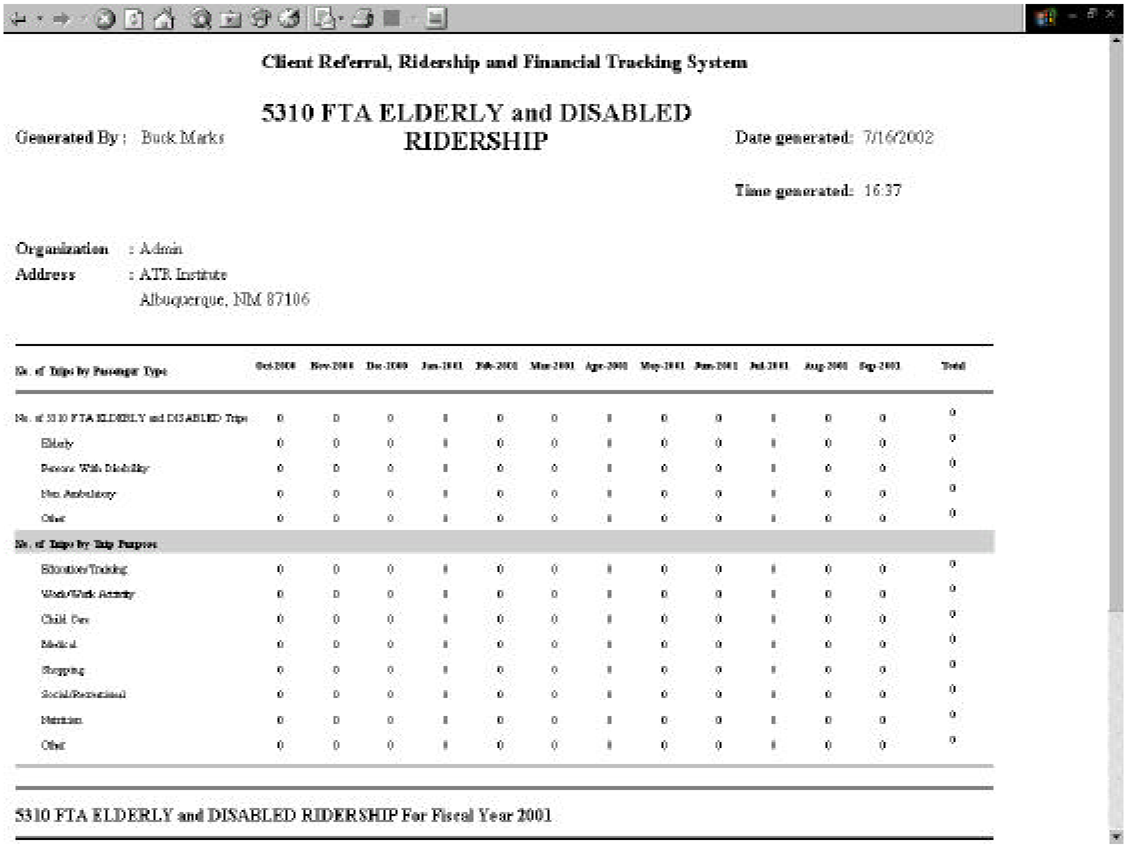


Figure 5-7: Vehicle Inventory Report Generated by CRRAFT



Client Referral, Ridership and Financial Tracking System

5310 FTA ELDERLY and DISABLED RIDERSHIP

Generated By : Buck Marks

Date generated: 7/16/2002

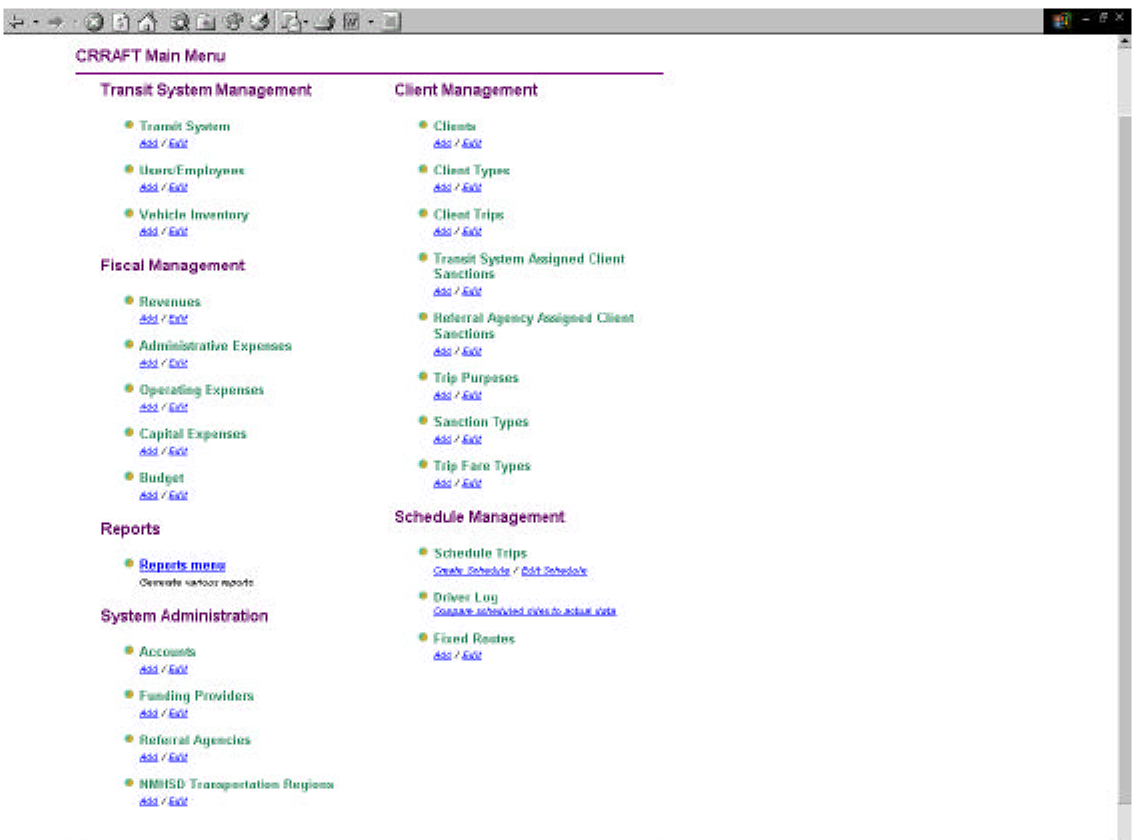
Time generated: 16:37

Organization : Admin
Address : ATR Institute
Albuquerque, NM 87106

No. of Trips by Passenger Type	Oct-2000	Nov-2000	Dec-2000	Jan-2001	Feb-2001	Mar-2001	Apr-2001	May-2001	Jun-2001	Jul-2001	Aug-2001	Sep-2001	Total
No. of 5310 FTA ELDERLY and DISABLED Trips	0	0	0	0	0	0	0	0	0	0	0	0	0
Elderly	0	0	0	0	0	0	0	0	0	0	0	0	0
Persons With Disability	0	0	0	0	0	0	0	0	0	0	0	0	0
Non Ambulatory	0	0	0	0	0	0	0	0	0	0	0	0	0
Other	0	0	0	0	0	0	0	0	0	0	0	0	0
No. of Trips by Trip Purpose													
Education/Training	0	0	0	0	0	0	0	0	0	0	0	0	0
Work/Work Activity	0	0	0	0	0	0	0	0	0	0	0	0	0
Child Care	0	0	0	0	0	0	0	0	0	0	0	0	0
Medical	0	0	0	0	0	0	0	0	0	0	0	0	0
Shopping	0	0	0	0	0	0	0	0	0	0	0	0	0
Social/Recreational	0	0	0	0	0	0	0	0	0	0	0	0	0
Nutrition	0	0	0	0	0	0	0	0	0	0	0	0	0
Other	0	0	0	0	0	0	0	0	0	0	0	0	0

5310 FTA ELDERLY and DISABLED RIDERSHIP For Fiscal Year 2001

Figure 5-8: 5310 Ridership Report Generated by CRRAFT



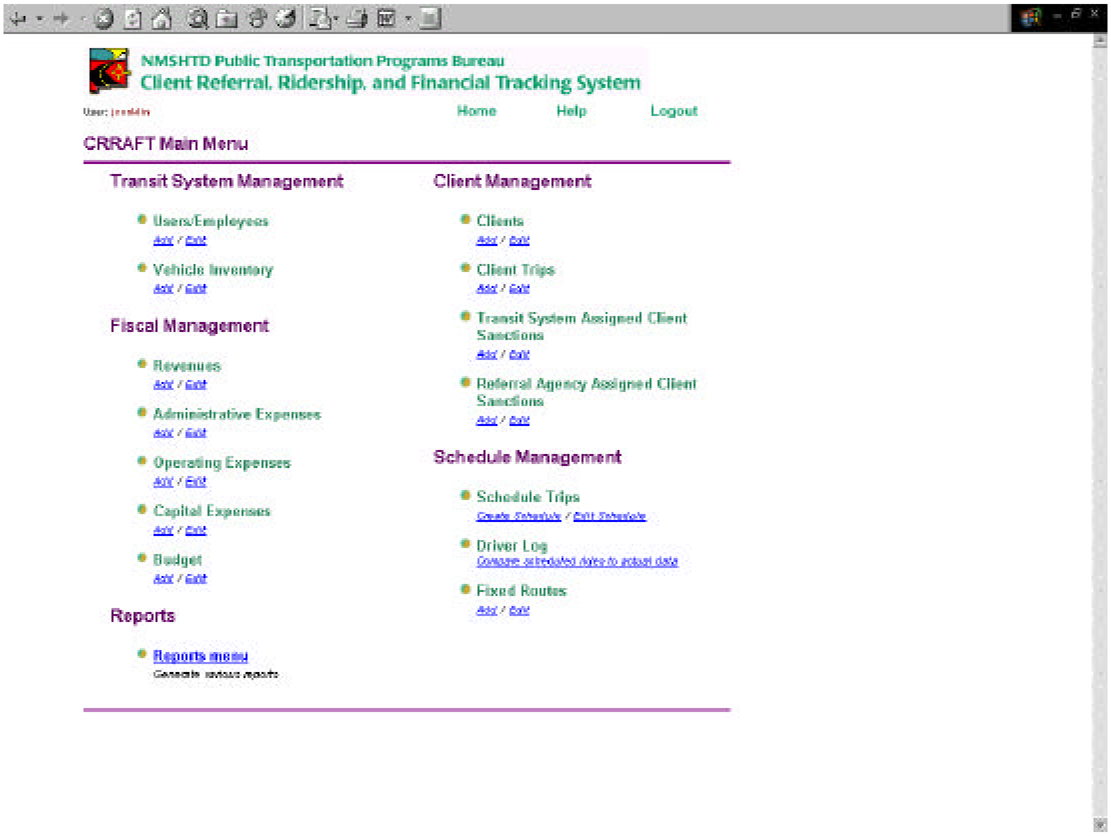


Figure 5-9: Modules in the CRRAFT System Available to Administrators
Figure 5-10: Modules in the CRRAFT System Available to Transit Systems

5.4.2 Technological Aspects of CRRAFT

The CRRAFT system consists of a Web-based software application programmed in Cold Fusion. Data validation in the CRRAFT software is done with the use of JavaScript, which is used by all Web-based applications for client-side form data validation. Encryption is done via the Secure Sockets Layer (SSL), which the programmers feel is a cost-effective, easily manageable method that provides the desired amount of security for the application.[23] While alternative methods of security (such as the use of a Virtual Private Network) would also provide adequate encryption, programmers felt they only needed to have a secure Web portal, which could be satisfied by using ordinary browsers and SSL.

The Web-based nature of the CRRAFT system eliminates the need for the support and development team to travel to dispersed locations throughout the state. The software and data reside on ATRI's server, so troubleshooting and upgrading will occur from ATRI in Albuquerque. The Institute will also serve as a neutral entity for coordination, user training, data integrity, and system security. All information transmitted over the Internet will be encrypted to ensure confidentiality and security.

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[23] The Secure Sockets Layer (SSL) is a commonly-used protocol for managing the security of a message transmission on the Internet. *(Source: http://www.whatis.com)*

5.4.3 The Electronic Benefits Transfer (EBT) Card

NMHSD has been using EBT cards to distribute food stamps to TANF clients for a number of years. The EBT Card is a high-coercivity magnetic stripe card containing a unique 16-digit number correlated to the client's social security number. The card can be used to purchase food, much like an electronic bank card would be used.

When ATRI started developing the CRRAFT system, they realized there was a disconnect between the automated CRRAFT system and the manual way in which many transit systems were tracking their riders. Therefore, they decided to explore the possibility of using an electronic farecard to track riders. They initially explored the possibility of using Smart Card technology, but decided the cost was too high. Since EBT cards were already being used for TANF clients, ATRI decided to start with the existing technology and design CRRAFT to work with the New Mexico EBT Card. Clients who receive transportation privileges will use their EBT card as a farecard in the public transit system. However, transportation providers will not have access to clients' social security numbers.

When boarding a transit vehicle, the client will swipe the EBT card through a magnetic stripe reader, which will record the client's identification number. At the end of each shift, the driver will download all transactions stored in the reader onto a driver's smart card, which will be programmed with the driver's name, the vehicle number, and the date and time. Information on the smart card will then be transferred to the transit system's main computer, where it will be transmitted into the CRRAFT database. CRRAFT will use this data to update each client's total number of authorized trips remaining. Thus, the card itself does not have stored value - it simply includes the identifying number of each client, which the CRRAFT system then uses to keep track of trips.

Passengers taking non-sponsored trips will use a magnetic stripe paper card purchased through the local transit operator. These cards will be disposable and may contain either a fixed number of trips (e.g., 5, 10, 20 trips) or be valid during a specified time period (e.g., monthly passes). Frequent general public riders may also receive a card similar to the EBT card (i.e., more permanent in nature).

5.5 Design, Operations, and Performance

5.5.1 Needs Assessment

ATRI has placed a continuing emphasis on encouraging feedback from the project participants in regard to development and functionality of the CRRAFT system. At the NMPTA Annual Conferences in 2000 and 2001, rural transit operators were given the opportunity to make suggestions regarding the functionality of the CRRAFT software. Additionally, the NMPTA Board periodically has the opportunity to review the software in progress and make suggestions. Furthermore, at a National Quality Initiative (NQI) on Transit in 2000, representatives from NMHSD, MNDOL, and the PTPB all got together to discuss their transportation reporting requirements. The results of this discussion had important implications for the design of CRRAFT since it determined the content and format of the reports produced by the system.

One of the services being provided by ATRI is a needs assessment at each of the transit system sites prior to system installation. ATRI conducted town hall meetings at sites across the state to gain input for product development. Additionally, they have conducted a technical needs assessment at each of transit systems included in the first phase of implementation. They will continue to conduct these needs assessments as they add transit systems to the system. The needs assessments examine the following:

- Existing hardware and software;
- Internet connectivity (including data transmission speed); and
- Computer knowledge of the system administrator and others who will have access to the system.

The needs assessments will determine the level of pre-implementation technical support needed at each transit system. In some cases, support will be provided by ATRI, while in other cases it will be provided by the transit system's technical staff or their corresponding municipality.

5.5.2 Training

As described earlier, the JPO and FTA have provided funding to help ATRI provide training for the users of the CRRAFT system. The ATRI will be conducting regional training for transit system staff using the "train the trainer" approach. A training session will be held in four out of five of the NMHSD regions. Each transit system may send two representatives to the training session who can then go back to their facility and train other personnel. The ATRI expects to complete training of 5311 and 3037 transit systems by October 1, 2002. FTA Section 5310 operators will be trained in FY2003. Part of this training will include instructions on client information confidentiality, which is expected to be an important aspect of the system. The Institute is also considering the possibility of using Web-based training tools, but has not yet fully developed this idea. Web-based training would not take the place of on-site training, but rather would supplement it. This type of training will give ATRI the means to provide ongoing training as the system evolves.

5.5.3 Maintenance of the CRRAFT System

When ATRI initially decided to develop CRRAFT, they considered three different models. One model would be a completely Web-based application that the client sites could access through an Internet browser. The application itself, as well as the data, would be housed at a central location, such as ATRI. On the other end of the spectrum is a model that included an entirely client-based software application, in which everything would be stored on the client's local system. The intermediate model would consist of a synchronized Web referral and client based software application. With this system, the referral module would be housed in a central location, but the transit provider would still have the remainder of the application installed locally on their system. Referral would be sent to the local systems, which would be used to perform the remaining functions such as report generation and vehicle scheduling.

After considering these different models, ATRI decided to develop a 100% Web-based system. One reason for this was the geographic distribution of the transit systems. Since the rural transportation providers are spread throughout the state, maintaining local systems could be time-consuming. Additionally, housing the application locally allows ATRI to easily make changes and improvements to the system that are automatically downloaded when local transit providers access the site. This arrangement also gives ATRI a high level of system control and allows them to easily set and re-set administrative privileges. In general, ATRI has been able to provide support to the transit systems over the phone, although they may consider a Web-based option in the future.

5.5.4 Operational and Other Challenges

According to ATRI, the CRRAFT project "has not been as simple as we thought it would be." One difficulty has been making the connection between the transportation operators and case workers, and getting them to work effectively together. This has required implementation of new statewide procedures for NMHSD, NMDOL and the PTPB. Implementing uniform processes continues to require good and frequent communication between the agencies.

The location of the Internet hub may be linked to the connectivity problems at one transit system.

Another major challenge ATRI has faced is the lack of adequate Internet access at some of the transit system sites, as well as insufficient technical support at these sites. For example, at the Los Lunas site, Internet access is frequently disrupted, hindering the administrators' ability to access the system. In this case, the problem may be linked to the location of the Internet hub, which has been installed in a utility closet. Other locations, such as the Zuni Reservation, are so remote that they do not have access to high-speed Internet connections. While there has been discussion of installing a fiber optic cable line to Zuni, this option is still in the distant future, since the cost would be at least $300,000. Because the Internet connections can be somewhat unreliable, CRRAFT has been designed to systematically save data that has been entered into the forms by users. Additionally, users only work with one form at a time. Therefore, only data in the form being used is lost in the event of a connection disruption.

From a software programming point of view, design of the security system was somewhat challenging, since different users of the system require different access levels to the software. The difficult part was in developing the security system to provide appropriate levels of access to users without making the system too complex. The security system design does not put much overhead on the server and database, and is easy to work with from a programmer's point of view, but took some thought and effort to design.

As ATRI refines CRRAFT, issues that need to be addressed continue to arise. For example, one significant problem they recently encountered was how to synchronize the different accounting systems used at the municipalities with the CRRAFT system. Because many of the rural transportation providers are municipalities or tribal governments, some of the accounting for transportation services typically occurs on the municipality's internal accounting system. For example, the municipality may track fuel usage and may simply send that information to the transportation provider at the end of the month. In response, ATRI resolved the problem so transit systems will not need to input duplicative data for their funding agencies. The solution allows the transit system administrator to enter data from the municipality's ledger into the CRRAFT system and those costs will be taken into account by the financial modules, which will allocate costs to each of the funding sources.

5.5.5 Perceived System Benefits

According to ATRI, the ridership and financial tracking modules are the most important features of the CRRAFT system. Of course, they also recognize that automating the client referral process will be important since the process essentially starts with client referral. Although the system is still in the implementation phase, ATRI sees a number of potential benefits that will be realized once CRRAFT is in place, including:

- **Collaboration**: The CRRAFT system will increase the level of collaboration between the transit systems and their funding agencies;
- **Efficiency**: The system will help transit systems better allocate their resources by improving the information available to them;
- **Level of Service**: By making the transportation more efficient, CRRAFT will allow them to provide more service for the same cost;
- **Access**: Providing a greater level of service will provide clients with better access to employment and training opportunities; and
- **Uniformity of Information**: Currently, each transit system has its own method for reporting to funding agencies. The CRRAFT system will increase the consistency of this information.

5.5.6 Staff and End-User Reactions

The transportation providers that have participated in the CRRAFT implementation to date requested to be included in project. When they were shown what the system could do, they saw some potential benefits to participating and were therefore willing to be the "guinea pigs" during the implementation phase. At the time of this case study, the transportation providers had only been using the CRRAFT system for approximately 1 week, so they were still learning how to use it and what its capabilities are. However, they appeared to clearly understand the potential benefits of using the system and intend to use many of the functions offered by CRRAFT.

Among the potential uses of CRRAFT mentioned by transportation providers were fiscal management (budget, utilization of funds), client management (tracking who clients are, where they are going, and what their funding sources are), schedule management, and the tracking of vehicle maintenance. They see a number of potential benefits to using the system, including increased efficiency through better schedule management, ease of reporting to funding agencies, ability to monitor performance measures such as on-time service delivery, an improved client referral system, and better load balancing on vehicles. One transportation provider estimated that the CRRAFT system will likely save three to four days of work per month just for reporting. The transportation providers also hope that the CRRAFT system will allow for better collaboration and coordination with the PTPB.

By increasing the cost effectiveness and efficiency of their services, the transit systems expect that the CRRAFT system will also improve customer service. The transportation providers will be able to use their vehicles more effectively, which in turn may reduce operating costs and help them provide more service for the same budget. The system will also help them detect potential maintenance problems more effectively so that they can be quickly corrected. Fewer vehicle breakdowns will result in better customer service. Similarly, the CRRAFT system will help them track the vehicle replacement cycle, which will result in an improvement in the agency's rolling stock. The transportation providers therefore feel that the CRRAFT system will help them improve their operations and that these improvements will, in the end, be passed on to their customers.

The transportation providers also recognize that the CRRAFT system will undoubtedly benefit the PTPB as well. Because the PTPB is the pass-through for transportation funding from a number of agencies, they are required to report to these agencies on a regular basis. Currently, the transit systems provide information in a variety of formats, which is difficult for the PTPB to process. CRRAFT will produce uniform reports, thus simplifying the reporting task for the PTPB. Additionally, the transportation providers believe the CRRAFT system will provide an accounting of the level of service being provided so that it can be better tracked and monitored. The transportation providers believe that CRRAFT can serve as a problem-solving tool for the PTPB and help in the information sharing process.

When asked what he thought other NMPTA members' reactions to CRRAFT would be, one transit system administrator replied that the reaction would be mixed, especially given the varying size of the properties and their differing level of technological advancement. For example, very small systems may see little benefit in investing the time necessary to learn the new system, particularly if they are accustomed to a primarily paper-based system. Additionally, some transportation providers might be afraid of the "big brother" aspect of the system. This sentiment was echoed by staff at ATRI, who recognize that it may be difficult to get full participation from all 26 rural transportation providers.

One of the areas in which the transportation providers are likely to differ is in whom they allow to have access to the system and what level of access is given to different individuals in the organization. For example, in Los Lunas the drivers will eventually be entering trip data into the CRRAFT system directly, whereas Zuni drivers will not have direct access to the system. However, the drivers will undoubtedly still benefit from the system since they will have better schedule information and less paperwork to keep track of once the automated farecard has been implemented. The administrator at each of the transit systems will have to make a decision about the level of control they want to maintain over the system.

Because the transit systems just recently started using CRRAFT, they have not yet been able to evaluate potential problems with the system. So far, the most significant problem has been Internet access, which has been spotty at both of the locations that are currently operational. Many of the transit systems will have dial-up connections, and connection speeds may therefore be slow for the individuals using the system. Additionally, there appear to be times when Internet access is simply not available, which can be a significant problem since administrators are unable to access the system when necessary. One of the administrators also expressed concern about being able to learn the system and "work out the bugs," which emphasizes the importance of providing the end-users with adequate training for using the CRRAFT system.

5.6 Project Costs and Revenue Sources

5.6.1 CRRAFT Development Costs

CRRAFT development has involved several distinct phases with funding provided by the FTA (through their ITS JPO and FTA 3037 program administered by the PTPB), NMHSD, NMDOL and the ATRI. A description and estimated costs of each phase are as follows:

- System Architecture design included an assessment of various transit system operations (policies and procedures), PTPB operations, and funding agencies' needs. Included was an inventory of transit system information system capabilities and recommendations for the minimum improvements needed for use of the CRRAFT. Completion of the System Architecture design was approximately $15,000.
- Development of the CRRAFT software for the first round of Beta testing was completed in June of 2001. The cost for this development was approximately $40,000.
- During the Beta testing phase, ATRI staff traveled to and worked with the transit systems previously selected for the testing. The testing period, originally scheduled for 60 days, was extended to 90 days because of time constraints encountered by the transit systems. The total cost of beta testing was approximately $10,000
- Following the completion of the Beta testing in September 2001, the ATRI spent seven months incorporating the users' suggestions and embarked on several major enhancements. The ATRI also began development of a training program and the ongoing writing of the CRRAFT User Manual. The total cost during this time period was approximately $50,000.
- The software was released in April 2002 to Los Lunas Transit and the Zuni Entrepreneurial Enterprise for another round of Beta testing. Development of the User Manual and Training Program continued unabated and the first training session took place on August 6 and 7, 2002. Costs for this phase was approximately $40,000. It should be noted that this is when the PTPB contracts were finalized and monies from the NMHSD, FTA JARC, and NMDOL also became available.

The total cost as of August 1, 2002 (for the components described above) is estimated to be $155,000. Under their present contracts with the PTPB and FTA/FHWA ITS JPO, the ATRI will, at a minimum, continue to enhance the software and User Manual, improve upon the training program, develop a report of the participant's evaluation of training and manual, and a best-practices report. The ATRI will also exhibit and discuss the CRRAFT at national and regional conferences related to Rural Transit. In total, the contract with the JPO, which runs through October 30, 2003, will provide $300,000 for the development of CRRAFT and associated activities such as training.

5.6.2 EBT Card

As noted previously, the ATRI has completed the Request for Proposal Process and selected ERG Transit Systems as the vendor to provide card technology to the transit systems receiving funding from the PTPB. This includes magnetic stripe and smart card technology for use by the clients and drivers, card readers for 200 vehicles located in 27 cities (which includes approximately 50 readers which will be held in inventory for repairs and replacement), and interface software to manipulate Equipment Operating Data and Usage Data for the CRRAFT. Contract negotiations are in the final stages with full deployment anticipated by July 1, 2002. Total cost of the swipe card project is expected to be approximately $550,000. Funding is through the PTPB from monies granted to them by the FTA 3037 program, NMHSD and NMDOL.

5.7 Considerations/Best Practices

5.7.1 The Planning Process

This case study emphasizes the importance of comprehensive planning when deploying ITS solutions. ATRI and the PTPB went through a detailed and thorough planning process, including town meetings in the areas where the transit systems would be involved in the project. ATRI also conducted technical and organizational needs assessments prior to writing a single line of code for the CRRAFT system. These needs assessments allowed them to understand the technical and organizational barriers that might hinder the successful deployment of CRRAFT. Specifically, ATRI used the information from the needs assessments to:

- Ensure that the transit systems could see the potential benefits of the CRRAFT concept and would thus agree to use it;
- Refine the software modules and functions so that they would benefit both the transit systems and the state funding agencies;
- Structure and design the software interfaces so that they would be readily usable by staff who were new to computers;
- Design reports that would be useful to the transit systems;
- Identify what type of training would be needed for users of the system;
- Assess what hardware and software upgrades transit systems would need, as well as their required level of technical support;
- Determine that a Web-based software solution would provide the connectivity and flexibility for a statewide system where the end-user sites are spread all across the state;
- Evaluate what issues transit systems might have in connecting to the Internet; and
- Begin to identify future enhancements that would benefit the transit systems.

5.7.2 Design Considerations

ATRI has been very successful in developing the CRRAFT software in-house. One of the reasons for this may be that, early on, they formed a development team similar to a commercial enterprise. For example, ATRI established design, development, testing, documentation, and evaluation groups, just as in a commercial operation. Another lesson from an internal development standpoint is that agencies who decide to develop a solution in-house should carefully think about the intellectual property rights that may be involved and potential future licensing issues. In ATRI's case, the developers had not yet thought about marketing their product on a broader scale, but recognized that this would be an important issue they would have to consider.

According to some of the programmers of the CRRAFT software, proper design of the back-end database is a key issue, since it affects the overall speed of the software. This was especially important since CRRAFT is a Web-based, database-intensive application system. The programmers put a significant amount of thought into the database design. Tables were normalized and designed keeping in mind that they would be used by CRRAFT to generate reports.

Expandability of the software is also important, as the needs of end-users will likely change over time. An example with the CRRAFT software is GIS capability, which has not currently been incorporated in the software package. The reason for this is that the transit systems do not currently feel that GIS is high on the functionality priority list. However, recognizing that it may become more of a priority in the future, ATRI has designed the software in a way that will accommodate the integration of GIS capabilities in the future.

As mentioned previously, ATRI conducted a 90-day Beta testing phase with five of the participating transit systems. After this phase was completed, ATRI asked the transit systems to continue providing comments as they found issues requiring attention. ATRI feels that the transit systems' input has been crucial in identifying where usability and page layouts needed improvement, text or instructions were unclear, and extraneous effort for data input was occurring. Additionally, the transit systems' input helped ATRI finalize the reporting format and variables in the system.

One of the ATRI representatives stated that, if he were to be involved in a project like CRRAFT again, he would have field staff sit with the transit system staff on a regular basis during the Beta testing phase. He believed that the transit system administrative staff encountered flaws in the system, as one would expect to find during a Beta test, and would become discouraged and move on to other work not related to the Beta testing. Thus, having an ATRI staff member sitting with the administrative staff would have allowed them to directly voice their frustration and feel support that would encourage them to move on. However, ATRI was not able to provide this level of support because of funding constraints.

5.7.3 The Procurement Process

Agencies should not assume that there is an off-the-shelf solution to an ITS challenge. Although ATRI and PTPB evaluated a number of existing off-the-shelf paratransit and related software products, they determined that none would be cost effective, particularly once customization was needed. The two partners decided it would be easier and more cost effective to build from the ground up, which would give them the most flexibility to refine, change, and add features over time.

5.7.4 The Installation Process

Initially, ATRI had envisioned that each transit system would do the initial data entry into the CRRAFT system. However, they soon discovered that transportation staff did not have the necessary time to perform this function. Consequently, ATRI staff decided to do the initial data entry (such as staff, clients, vehicles, etc.) for the transit systems in order to speed up the installation process. ATRI's flexibility on this issue allowed them to get the system up and running more quickly, and also helped them avoid the more complex task of creating an automated upload of data with CRRAFT.

Additionally, ATRI maintained a test version of the CRRAFT software while they were implementing the live site, which allowed them to work with the participating transit systems when problems arose. The test site was populated with sample data so that ATRI staff could try to simulate errors experienced by transit systems. Keeping a test version available allowed them to more efficiently solve problems during the initial implementation phase without having to disrupt access to the live site by transit systems.

5.7.5 Other Considerations

In addition to those mentioned above, this case study highlighted a number of other considerations for agencies that are thinking about implementing a similar ITS solution, including:

- When deploying an ITS solution, agencies should keep abreast of the potential for alternate funding agencies in case existing sources dry up or become temporarily unavailable. In the case of ATRI, some issues with the State caused them to have to fund the project on their own for some time. However, the benefit was that it also forced them to look elsewhere for funding sources, which ultimately resulted in the participation of the FTA and JPO.
- It is important to prove to participants that the ITS application will have benefits to them. Although it may be difficult to quantify these benefits, providing at least a description of how they can use the system to improve their operation can greatly increase their willingness to participate in the project.
- Centralized, convenient, and semi-automated billing is not only important at the state level, but can also be important and beneficial to the organizations providing transportation services.
- Agencies developing ITS applications should be sure to allow for sufficient training of end-users, as well as budgeting for ongoing support.

5.8 Future Plans

As of April 2002, the CRRAFT system has been implemented at two test sites: Los Lomas and Zuni. ATRI will be conducting the remaining training on a regional basis and plans to have all of the transit systems on-line by October 2002. The on-going needs assessments being conducted at the various transit systems will continue to be an important piece of the CRRAFT implementation plan.

In terms of added functionality, ATRI plans to automate the referral process, as described earlier. This function will include electronic notification to the transit systems by the regional agencies when a client has been added to their list. Additionally, they plan to improve the software's ability to handle subscription trips, so that these trips could be saved in the system and potentially formulated into service routes. ATRI has also discussed added functionality for the CRRAFT system with NMHSD. The agency may want to integrate a transportation assistance and employment module that would give case workers a way to track all types of transportation assistance given to clients, including gas vouchers, bus passes, car repair funds, etc. Then the software could produce reports showing the amount and type of transportation support received for any time period, by client. NMHSD would also like ATRI to integrate information about clients' work activities and employment so that they could look for relationships between transportation assistance type and employment duration. However, this functionality is not yet in the planning stages, so it will not be added for some time.

While the initial implementation phase for CRRAFT includes primarily TANF, JARC, and WtW clients, the Institute plans on incrementally adding other agency clients to the system. For example, they recently received a $100,000 grant from the Developmental Disabilities Planning Council, which would like to be included in the CRRAFT system. ATRI recognizes that changes will have to be made to the system as more agencies (with specialized needs) are added, but since the system is Web-based, implementing these changes should not be exceptionally complicated. NMISD has also suggested that, if the CRRAFT system is successful in tracking TANF transportation trips, they may be interested in including Medicaid trips in the CRRAFT system. However, one of the challenges in including Medicaid trips in CRRAFT will be incorporating the private, for-profit carriers that provide Medicaid transportation.

Figure 5-11 shows ATRI's ultimate plan for the New Mexi-Card Tracking Information System. Each subsequent level in the chart indicates a more advanced phase in the project. Currently, Levels 1 and 2 are in place or in progress. It should be noted that the arrow connecting Level II back to Level I represents the fact that the NMHSD EBT card will be used as the PTPB Transit Farecard. Level III shows integration of Medicaid transportation (the Medical Assistance Division – MAD) and the Navajo Nation. While Medicaid is located within an agency currently participating in the ITS deployment, it will be a significantly more complex integration than the one that has already been done with WtW and JARC clients, and is thus included in Level III rather than Level II. Currently, ATRI is working with the Navajo Nation, which has committed $35,000 to assess their computer needs for inclusion in the project. Therefore, that portion of Level III may occur in the near future.

Level IV includes integration of the Women, Infants, and Children (WIC) Program, which will be a challenge since the agency is currently using a different type of benefits card. Level V illustrates ATRI and the PTPB's ultimate vision, which is to implement one card, called the New Mexi-Card, which can be used for all governmental programs. The graphic shows that the card will be integrated with the state's Motor Vehicle Division (MVD). Thus, the vision is to have a completely integrated system for all governmental services and the current project is a stepping stone toward realizing that vision.

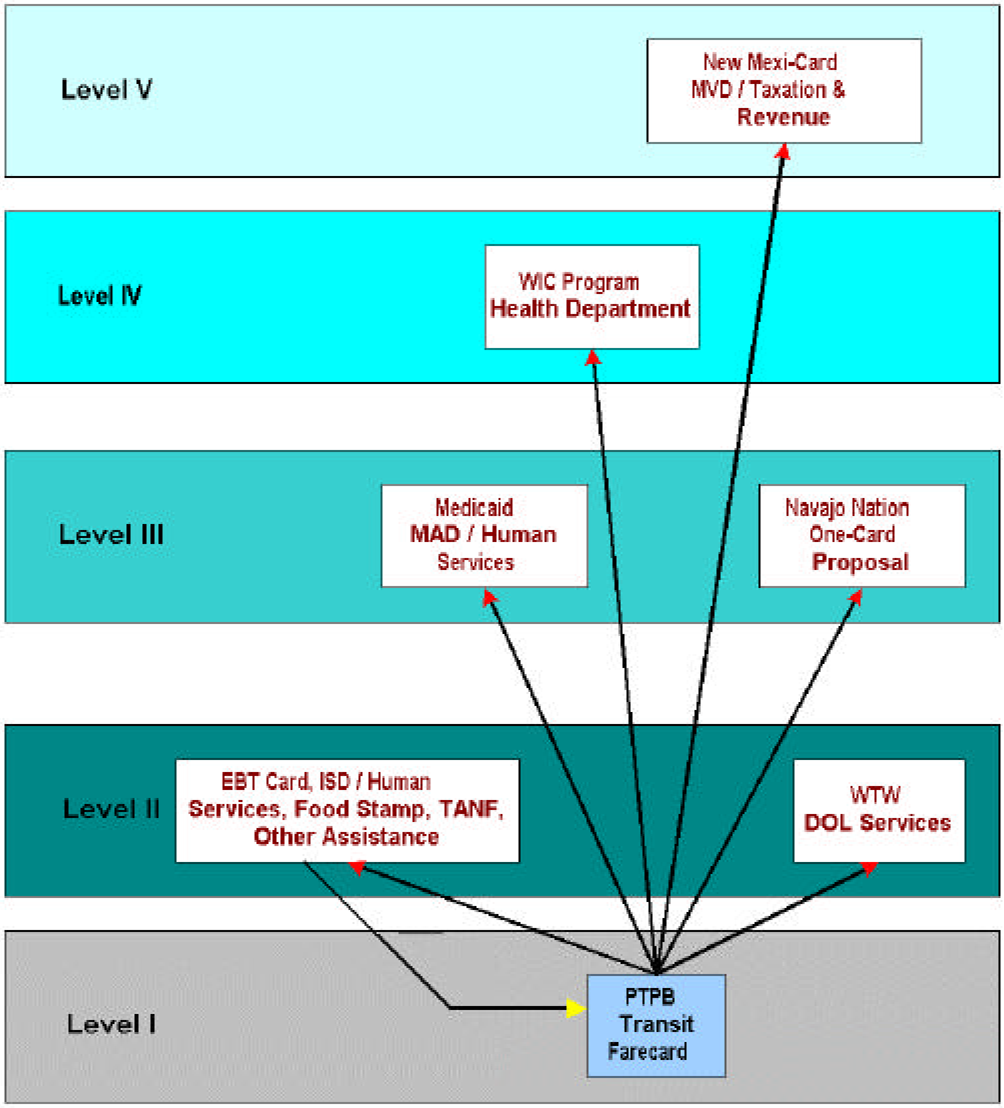

Figure 5-11: New Mexi-Card Tracking Information Flow Chart
Source: Alliance for Transportation Research Institute

6.1 Case Study Overview

Ottumwa Transit Authority (OTA) was selected as one of the Rural ITS case studies because it has implemented several important ITS components. Moreover, the agency is responsible for providing bus service in Ottumwa, Iowa and the surrounding 10-county area covering 5,000 square miles, a fact that makes the potential impact of ITS applications more significant. After attempting to share resources with nearby Linn County, OTA installed its own new two-way radio system, which improved voice communications and provided bandwidth for its AVL/MDT system throughout the agency's large service area. One unique feature of OTA's system is a form-based, MDT log-on/pre-trip procedure that requires drivers to automatically transmit information to central dispatch regarding the mechanical condition of a vehicle. This feature is especially useful for the 40 vehicles that are garaged at drivers' homes, some of which are over 50 miles away from OTA headquarters. The OTA uses this pre-trip information to determine if maintenance should be scheduled at the agency's central garage or could be repaired by one of its subcontracted, out-of-county mechanics.

The ITS package has been in place for about 18 months. The project team felt that although the agency has encountered and continues to work out various problems, much could be learned from an operational perspective.

6.1.1 Ottumwa Transit System Overview

OTA is a department of the City of Ottumwa rather than an independent authority. However, OTA is considered an "enterprise" department, operating somewhat independently, and has its own governing board. OTA’s staff include a Transit Administrator, four call takers/schedulers/dispatchers (henceforth simply referred to as dispatchers), 46 full- and part-time drivers, and two maintenance personnel.

OTA provides both fixed route and demand response services in the City of Ottumwa and the surrounding 10 counties. The 10-county area covers approximately 5,000 square miles with a population of only 140,000 people, or about 28 persons per square mile. The large service area and low population density were key factors in the design of the ITS application.

OTA services include:

- Fixed routes in the City of Ottumwa;
- ADA paratransit in the City of Ottumwa; and
- Demand response paratransit and regional rural services in the remaining 10-county area (this is referred to as the "10-15" service because OTA is part of IDOT’s region 15 and its service area covers 10 counties).

The agency operates 51 vehicles: nine fixed route vehicles, two ADA paratransit vehicles, and 40 “10-15” vehicles. Only 11 of OTA’s vehicles are actually based in Ottumwa. The remaining 40 are based at drivers' homes in the outlying areas, some as far as 50 miles from the central OTA facility. This dispersal of vehicles creates a vehicle and personnel management challenge for the agency. Many of OTA's ITS project goals relate to operating the system more effectively in this large, rural area, where drivers and vehicles are based in outlying areas far from the central operating facility. OTA has its own two-bay maintenance shop at its Ottumwa facility. All local vehicles are serviced and maintained at this location, while remote vehicles are brought in for major repairs. Outlying vehicles get minor service via subcontractors. One feature of the MDT system described below is a direct result of this maintenance arrangement.

OTA currently operates its demand-response services with four dispatchers. Each dispatcher has an AVL/CAD workstation and radio base station for communicating with the drivers. For ADA and regular demand responsive paratransit service, each dispatcher has an assigned geographic region. One of the dispatchers covers the ADA service in Ottumwa (as well as fixed route dispatching), while the two other dispatchers split up the remaining area in the outlying counties where the "10-15" service is provided.

Scheduling is currently done manually. The dispatchers have developed an Excel spreadsheet listing each paratransit run for each day of the week. As they take trip requests, open slots in the schedule are filled in by hand. Manifests are given or sent to drivers each morning. OTA staff must fax daily trip manifests to local Councils on Aging or other locations where remote drivers can pick them up. Because OTA has a large number of standing order trips, the dispatchers have formulated some "service routes" with the help of the AVL and Scheduling System.

6.1.2 OTA Case Study Field Work

The research team coordinated the site visit with the Transit Administrator, Pam Ward, who provided detailed information and access to her staff. During the site visit, which took place on January 29 and 30, 2002, the team interviewed the Transit Administrator, drivers, and dispatchers. Dispatchers were also observed and questioned while they used the system to obtain a first-hand understanding of how the ITS application works.

6.2 Project/System Background and History

Prior to the implementation of this project, OTA was using a combination of communications equipment. The buses and ADA vans within Ottumwa City used hand-held (portable) UHF radios to communicate with the base dispatcher. The regional "10-15" vehicles were equipped with VHF radios, although OTA did not have a central base station. The vehicles could communicate with each other and a base station at one of the remote sites in the outlying areas. In 1993, OTA began using cellular telephones for the rural service at a cost of about $14,000 to $16,000 annually. All scheduling and dispatching was done manually. Driver manifests were prepared by hand although, independent of the ITS project, the dispatchers began using an Excel spreadsheet to assist them in the scheduling process.

OTA’s interest in a more advanced ITS application grew out of a desire to be able to operate their service more effectively, given the large, rural service area they served. They wanted to be able to locate their vehicles in real-time communicate more easily with drivers. The agency also hoped to minimize the extensive paperwork necessary for reporting purposes. An ITS application to meet these needs had been mentioned in the Iowa statewide ITS Architecture. Also, OTA had been in communication with Cedar Rapids, which had implemented a system similar to what OTA was envisioning.

The procurement and implementation process ultimately affected the project's success. The project had a number of false starts. The first false start began in 1995 when OTA received an earmark from FTA for a demonstration project. The agency initially intended to use this grant to purchase an AVL/MDT system from Rockwell, which had been successfully implemented in Cedar Rapids. Although OTA had a signed letter of intent with Rockwell, FTA did not agree to allow a sole source contract. Therefore, OTA had to competitively bid the project. In the meantime, Rockwell temporarily exited the market and new vendors were entering it. At about that time, OTA began using the FTA peer-to-peer network to assist with procurements and project implementation, which led to the hiring of an outside consultant to develop the technical specifications and manage the procurement process.

The second false start involved the proposal process. After the Rockwell project was not started, OTA drafted specifications. However, the agency only received one proposal, which was for an amount higher than the project budget. This bid was rejected.

The final procurement process began when OTA refined the specifications and rolled back the qualifications to allow for a broader range of vendors. The new specifications were a hybrid of functional and technical specifications, and resulted in proposals coming in from a number of vendors. OTA selected the partnership of Radio Satellite Integrators (RSI) and StrataGen as contractors for the project, based on the selection committee’s conclusion that the team had the best-proposed product and cost. RSI was to provide the communication systems and GPS capability, while StrataGen was to provide the CAD. RSI was to be the systems integrator. While the two vendors were initially selected as a team, OTA's funding agencies ultimately insisted that the agency enter into two separate contracts with the vendors.

However, another complication arose with the procurement after RSI was under contract. In their bid, RSI had proposed that Motorola radios be used for communications. However, IDOT and FTA did not feel comfortable with including the communications infrastructure in the contract and required that OTA procure the communications hardware separately. Thus, OTA was required to put this component of the system out to bid as well. While this extra step did allow them to get the lowest available price, it also slowed down the project’s procurement process and added to the administrative costs involved in obtaining the quotes.

As originally envisioned, the ITS application had a number of components. The central focus of the deployment was the use of AVL/MDTs for messaging between the drivers and dispatchers, vehicle location, pre-trip inspections, and driver monitoring. This portion of the project has been implemented fairly successfully, although there still are some software glitches. The project also had a scheduling and dispatch software component. The software has been installed on the

Ottumwa's rural ITS deployment includes MDTs, which are used for communication between drivers and dispatchers and for pre-trip inspections.

OTA computers, but has not yet been integrated with the AVL/MDTs and is not currently being used.[24]

The ITS project has taken a significant amount of time to implement. The original FTA grant was signed in 1995. It took until the end of 1999/early 2000 to begin implementation of the AVL/MDT; it took until the summer of 2000 to begin implementation of the scheduling and dispatching software. RSI was under contract in August 1999 and StrataGen was under contract in June 2000.[25] However, once the contracts were signed, installation and start up happened quickly with limited installation completed by January 2000 and full installation completed by March 2000. Installation of the scheduling and dispatching system occurred in March 2001, but this component is not yet operational.

6.3 Project Goals and Objectives

6.3.1 Stakeholders

Project stakeholders included OTA staff, as well as the OTA Board, officials for the City of Ottumwa, and County Engineers. Iowa DOT and the FTA, as funding agencies, were also key stakeholders. A tangential stakeholder was Johnson County, which was considering a similar project. Supporting these stakeholders was the ITS Project Manager, consultant Carl Thornblad. The vendors, RSI, StrataGen, and Illowa (the Motorola radio representative) were also considered stakeholders.

However, stakeholders outside of OTA often had multiple motivations. For example, the FTA and IDOT staff were interested in ensuring that FTA procurement requirements were being followed, the vendors wanted to make money and create a market for their product in the state and nationally, and other operators in the state were interested in using OTA as a testing site for the technologies.

Within OTA, there was some reluctance on the part of the drivers to accept the new system. The apparent reasons for this included: 1) some drivers not wanting to learn anything computer-based, and 2) the feeling that the AVL system allows management to check up on them (i.e., the "big brother" fear). On the other hand, there are parts of the system that the drivers like such as completing the pre-trip inspections without the paperwork. The drivers also appreciate the fact that the AVL system allows management to substantiate where they were in answer to customer complaints.

6.3.2 Goals and Objectives

OTA had a number of goals for the project as it was being conceived:

- Communicate seamlessly and reliably with all vehicles;
- Locate all vehicles in the service area, especially the 40 vehicles based outside the Ottumwa facility;
- Improve safety and security of the system vehicles, drivers and passengers, specifically because much of the service is provided far from the central facility;

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[24] OTA severed their contract with StrataGen as of June 2002. However, they may still participate in a State-level project for this component if arrangements can be made.

[25] The AVL/MDT agreement between RSI and OTA was dated August 1999 and the amendment was dated March 21, 2000. The final contract with StrataGen Systems Corp. for the CAD was dated June 6, 2000.

- Communicate maintenance problems and pre-trip inspection reports directly to the base; and
- Apply technology to facilitate the agency's billing process.

The AVL/MDT portion of the project was meant to address the first four goals. While none of the initial goals required scheduling and dispatching software specifically, the data generated by this software will ultimately be used to assist in the billing process. Specifically, the software has the capacity to generate invoices for customers based on their use of the system. Currently, this invoicing is being done with the use of a spreadsheet and is a very labor-intensive process.

6.4 Description of the Application and Technology

6.4.1 General System Characteristics

OTA's ITS deployment consists of AVL with MDTs, a new VHF radio system, and dispatching and scheduling software. For the AVL/MDT system, each dispatcher has a workstation. The software has a vehicle locator function that dispatchers use to view multiple map windows (presets and dynamic). Dispatchers can view the location of a bus by its number, using the "locate vehicle" box on the software's toolbar, as displayed in figure 6-1. Dispatchers can also use the software to produce vehicle activity reports and vehicle activity maps to track where the vehicle has gone, where it has stopped, and for how long. An example of a vehicle activity report produced by the system is shown in figure 6-2. Reports on when a driver has shut off a vehicle or when it has stopped for a long period of time are used by management to monitor driver activity.

Each driver has an MDT unit on his/her vehicle that is used to log on and log off, and conduct pre-trip inspections. If working properly, the MDT is used to communicate with the dispatchers through the text messaging function. Likewise, dispatchers can send messages to individual drivers via the MDT.

The dispatchers have a number of screens. The text messaging control screen has an envelope symbol for each vehicle. The AVL/MDT "chat screen" emits an audible alarm and the envelope turns yellow when a message is received, as shown in figure 6-3. As seen in figure 6-4, dispatchers can choose from a scrolling list of canned messages when communicating with drivers. Additionally, the dispatcher can review a message history of up 10 messages per vehicle, as shown in figure 6-5. The AVL system is tied into emergency alarm buttons in the vehicle cab area and on devices that the drivers carry on their key chains.[26]

[26] As of February 2002, the text messaging was not operating correctly and transmission of many messages were either delayed or cancelled, with no notification to the sender or intended receiver. Thus, the drivers and dispatchers were still relying heavily on radios and mobile telephones. However, the system was working well for the "10-15" drivers, who use text messaging more frequently than voice communication.

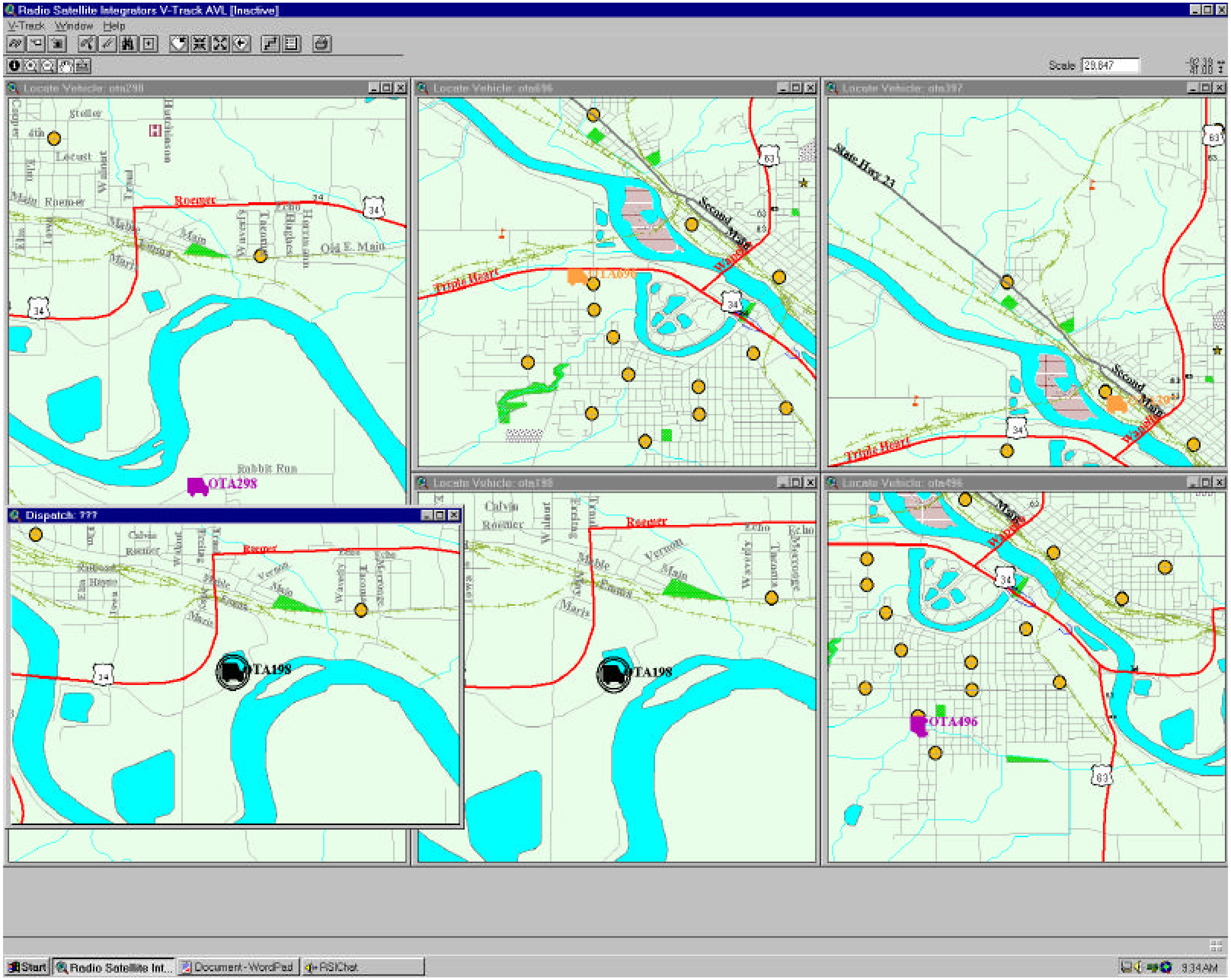


Figure 6-1: Result of "Vehicle Locate" Routine in OTA's AVL System

Vehicle Activity Report

Activity Date: 1999-10-03
Vehicle: 307

Generated On: 1/10/00 1:36:43PM

Time	Description	Location	Time Stopped	Time Moving	Time@Location
15:57:44	Arrived	107 Main Street	00:00:13	00:00:00	00:00:13
15:57:57	En Route		00:00:00	00:05:41	00:00:00
16:03:38	Arrived	300 South 4th Street	00:00:19	00:00:00	00:00:19
16:03:57	En Route		00:00:00	00:39:49	00:00:00
16:43:46	Arrived	210 East Argyle	00:05:32	00:00:00	00:05:32
16:43:52	Ignition Off	218 South Eagle Avenue	00:00:00	00:00:00	00:00:00
16:48:51	Ignition On	316 North 1st Street	00:00:00	00:00:00	00:00:00
16:49:18	En Route		00:00:00	00:00:10	00:00:00

Time Stopped: 00:06:04
Time Moving: 00:45:40

Time On Location: 00:06:04

1 of 1

Figure 6-2: Sample Vehicle Activity Report Produced by OTA's AVL/MDT System

As stated previously, the MDTs are also used to complete a pre-trip vehicle inspections as part of the log on process, as shown in figure 6-6. The on-line inspection screens were designed based on transit reporting requirements from the State and therefore help OTA in complying with these State requirements. To log on, the MDT prompts the driver to enter their driver ID number and beginning mileage, then fill in the electronic pre-trip inspection form, which consists of 54 items on 13 screens. Once the pre-trip inspection forms have been completed, dispatchers or the Administrator can print reports showing pass/fail status of each vehicle and the major problems identified. For log-off, the driver is required to enter only the ending vehicle mileage. The pre-trip form was a customized feature requested by OTA because its vehicles are so widely dispersed throughout its service area. The form allows them to electronically comply with a State regulation for pre-trip data gathering.

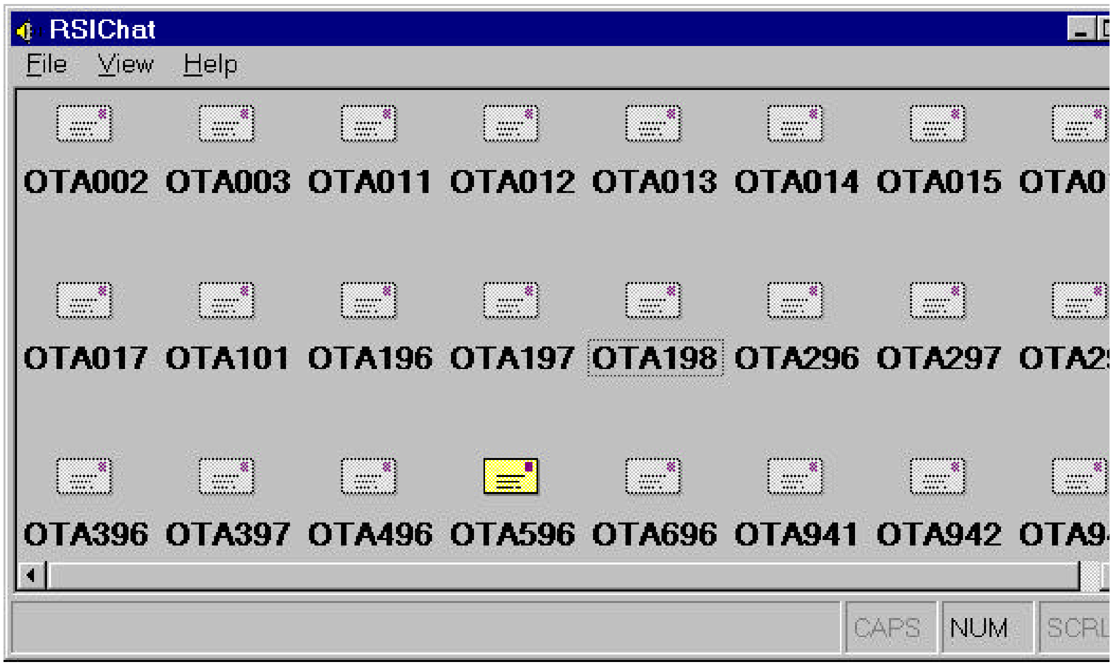


Figure 6-3: OTA's Dispatcher Chat Screen

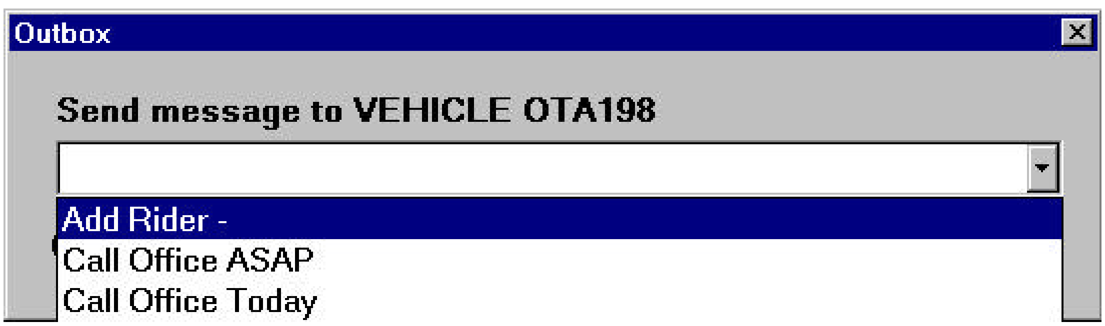
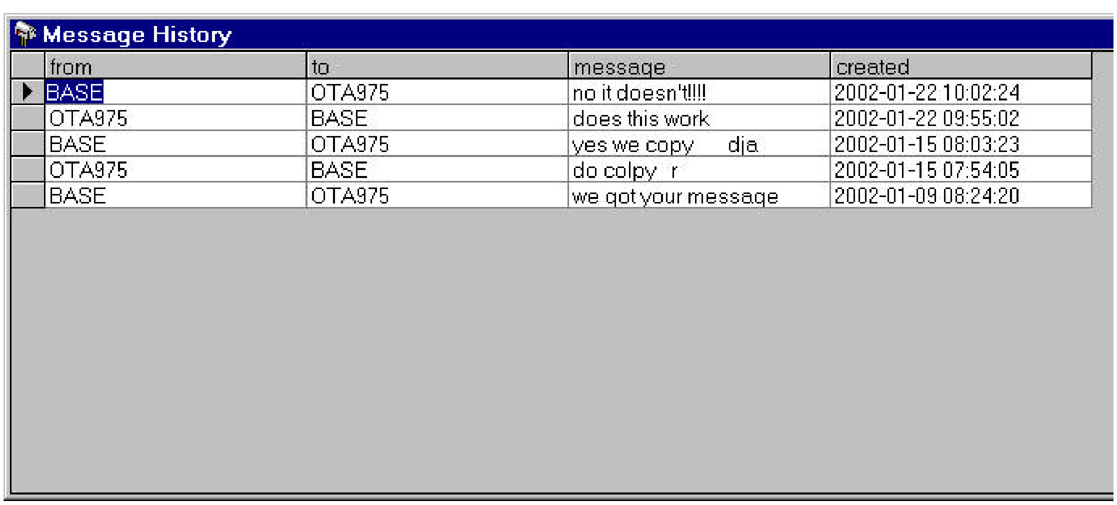


Figure 6-4: OTA's Dispatcher Message Interface



from	to	message	created
BASE	OTA975	no it doesn't!!!!	2002-01-22 10:02:24
OTA975	BASE	does this work	2002-01-22 09:55:02
BASE	OTA975	yes we copy dja	2002-01-15 08:03:23
OTA975	BASE	do colpy r	2002-01-15 07:54:05
BASE	OTA975	we got your message	2002-01-09 08:24:20

Figure 6-5: Message History Available to OTA Dispatchers

Figure 6-6: Pre-trip Inspection Completed by OTA Drivers on their MDTs

The system generates a number of reports that are useful to the dispatchers and the Transit Administrator. For example, the Transit Administrator can print out a summary of driver log-on/log-off times, which is useful for payroll purposes. Schedule adherence reports show the status of all vehicles at any point in time, and vehicle activity reports show all of the activity for a specific vehicle on a given day. Information from the AVL/MDT database can be queried, summarized, and reported using Crystal Reports software provided with the system. However, OTA staff did not receive training on how to use the software and consequently can only generate reports that were designed into the original system.

6.4.2 Technological Components

AVL/MDTs

The AVL System consists of the in-vehicle equipment (the MDT and GPS equipment), the radio that provides the data communications link between vehicles and the base, and AVL tracking and display systems at the operations base (dispatch). Fixed route vehicles are polled by the GPS every 2-3 minutes, regional vehicles are polled every 5 minutes, and ADA vehicles are polled every minute. OTA provided the radio frequencies, all non-vehicle radio infrastructure, and a radio in each vehicle (procured under a separate contract). The AVL system uses ArcView GIS and the vendor used Census Bureau TIGER files (Topologically Integrated Geographic Encoding and Referencing system) to populate the GIS. OTA says that the mapping is adequate, although five of the ten counties served by OTA do not have emergency 911 addresses, making the vehicle location less precise. However, the project team observed that in a service area this size, there is probably no loss in practical accuracy.

The AVL system was supplied by RSI. The specific system procured was the RSI *V-Track* Vehicle Tracking System, which integrates GPS, radio data communications, and GIS.

Communications System

This Motorola base station is part of the communications system procured by OTA in their rural ITS deployment.

OTA procured a completely new VHF radio system to provide the wireless communication system for the overall project, and to replace the existing use of cellular telephones for communications. OTA secured licenses for five frequencies in the 153 to 157 MHz range, which they intended to operate using four leased, shared use radio towers. However, OTA equipment at one of the four towers had to be disabled due to interference with RF equipment being operated by the tower's owner. The effect of losing the use of the fourth tower has been significant. The two counties that would have relied on this tower (encompassing approximately 10% of OTA's service) have not had consistent radio communication between the vehicles and the base in Ottumwa. Therefore, as of December 2002, OTA was attempting to reinstate the use of the 4th radio tower so that the reliability of radio communications in this area could be increased.

The radio installation was performed by a subcontractor, Illowa, a Motorola dealer. The system uses Motorola's M-1225 mobile radios. The radio communications system was intended to be the backbone of the overall ITS deployment.

Scheduling and Dispatching Software

The scheduling and dispatching software consists of fully automated software that is designed to operate on the existing OTA computer equipment. The software will ultimately be integrated with the AVL/MDT system without duplication of software, mapping, GIS data, and other items available at the

OTA operations base.[27] StrataGen's ADEPT software was installed on five workstations. It will be modified for custom reporting and billing. The integration with the AVL/MDT included common data to be used by both systems, including ArcView Mapping and GIS Street data and Quest Vehicle Maintenance System data.

6.5 Design, Operations, and Performance

6.5.1 Needs Assessment

OTA staff indicate that, because of the history of the demonstration project, minimal planning was done prior to entering into the procurement process. Primarily, this was because OTA thought they could enter into a sole source contract for a Rockwell product. No formal needs assessment was done, but new objectives and goals emerged as the system was implemented.

6.5.2 Training

OTA's contract with RSI includes on-site training for staff in the operation of all parts of the system and in producing the necessary operational reports. The contract also specifies that RSI will train one or more persons to install and remove the MDTs on the vehicles for maintenance purposes. Additionally, the vendor will provide instruction and operating manuals for all parts of the system (but had not done so as of February 2002). As of February 2002, there were several training issues that still needed to be addressed.

Additionally, information from the AVL/MDT database can be queried, summarized, and reported using Crystal Reports software provided with the system. However, OTA staff did not receive training on how to use the software and consequently can only generate reports that were designed into the original system. The agency has also purchased vehicle maintenance software by Qquest, but has not yet put this software to use.

For the scheduling and dispatch system, StrataGen was supposed to supply 5 days of on-site instruction for OTA staff.

6.5.3 Maintenance of the System

RSI provided a one-year maintenance agreement on the AVL/MDT system as part of the original purchase price. OTA also had an option for annual extended warranty agreements for up to five years, the price of which was to be negotiated prior to the final payment in the AVL agreement. As of February 2002, OTA maintenance personnel were servicing and maintaining on-vehicle equipment. When an MDT malfunctions, OTA staff try to repair it. If they are unable to do so, the unit is pulled and replaced with a spare, and the malfunctioning unit is sent to the vendor in California for diagnostic testing and repair. However, the MDTs do have "flash" capability, which allows RSI to easily make

[27] The contract specified that additional transit agencies would have been allowed to procure the same or a similar type of scheduling/dispatch system from StrataGen at the same cost if the transit agency's volume was equal to or less than the number of trips provided by OTA. If the system had a greater volume, or required additional operational features and customization, StrataGen and the procuring agency would determine the differences in cost that were acceptable for both parties.

updates to the system when the vendor comes to OTA's facility to make repairs.[28] Additionally, the software is enabled with PC Anywhere capability, which allows OTA to easily download software updates.

6.5.4 Operational and Other Challenges

According to Pam Ward, the Transit Administrator at OTA, the agency's ITS deployment has resulted in many benefits, but the agency has also experienced a number of challenges in getting the system up and running.

Some parts of the AVL/MDT system were not fully functional as of February 2002, with both the AVL polling and MDT text messaging not working properly. The AVL/MDT system was still having messaging problems. For example, sometimes there was as much as a 2-3 week delay until the intended receiver receives a message. Furthermore, the system was not designed to provide notification for the sender or recipient, exacerbating the problem. Therefore, drivers and dispatchers had developed a protocol for sending back a message saying "ok" with their initials when a message *was* received. Because of this issue, OTA has had to continue relying on radios and mobile telephones for communication. The agency has not been able to eliminate tower charges or cell charges, as originally intended, because MDT messaging is not reliable. Additionally, as mentioned earlier, the drivers are not consistently completing the pre-trip inspection reports on the MDTs because they are unsure whether the reports will be transmitted.

OTA also experienced some problems with vehicle polling, although some of these problems have since been resolved. At one time, up to 25% of the vehicles were not being polled. As with the text-messaging problem, there was no pattern to the non-polling. The problem was linked to the communications system not being configured to have the necessary capacity to handle both voice and data transmissions simultaneously.

The scheduling and dispatch software was installed on OTA's computers in March 2001, but was still not being used as of February 2002. Final testing and acceptance of the scheduling and dispatch system will be done only after all installation and initial training has been completed and accepted by OTA, as required in the contract. This includes final tests of the completed operating system performed by drivers and staff for one month.[29]

In addition, RSI had vehicle maintenance software in their original bid, but this component was ultimately deleted from the contract. OTA purchased another maintenance software product and tried to integrate it with the AVL/MDT, but the interface was not yet functional in February 2002. The agency hopes to integrate the two systems so that mechanics will be able to use the pre-trip information provided by drivers at login for vehicle maintenance.

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[28] "Flash" capability refers to an initialization program that is entered into the target system (such as the MDT) to make changes. Updates to the target system can be "flashed" via a number of methods, including a flash memory card or infrared transmission.

[29] OTA severed their contract with StrataGen as of June 2002. However, they may still participate in a State-level project for this component if arrangements can be made.

On the communications side, a very basic radio systems coverage analysis was done prior to project implementation. The analysis included elevations and coverage potential to determine the best locations for towers, among other things. However, radio communications continue to be a problem for OTA. The agency is currently using the County's towers, which has allowed them to minimize communications costs. Initially, there was a conflict between OTA's equipment and the equipment on one of the towers. This conflict resulted in OTA having access to one tower fewer than initially anticipated.

6.5.5 Perceived System Benefits

Overall, management at OTA feels that the ITS project has been beneficial for the agency. The project has had a number of benefits, as described below.

Service Efficiency

The agency believes the system has and will continue to improve service efficiency, particularly in the remote portions of their service area. Dispatchers can observe where vehicles actually are located, allowing them to more efficiently schedule trips (particularly same day trips). This is especially important at OTA, where the drivers often use multiple paths to get between a particular origin and destination. Ultimately, OTA also hopes that the scheduling system will help with batch scheduling, including both subscription and other types of trips.

Vehicle Maintenance

Once the Qquest vehicle maintenance software is integrated with the RSI system, OTA hopes that mechanics will be able to use the pre-trip vehicle inspection information entered into the MDTs by drivers to inform and improve maintenance decisions.

Safety and Security

Since the system vehicles, drivers, and passengers are so dispersed, the communications links provided by the AVL/MDT system are very important from a safety and security perspective. Dispatchers can respond more quickly incidents because they know exactly where the vehicles are.

Billing and Reimbursement

OTA hopes the scheduling and dispatch system will eventually help with the billing and reimbursement function. OTA works with a number of different funding agencies and the paperwork can be a time consuming task. Once the StrataGen system is fully implemented, reports can be generated that will help with reporting functions. Currently, information required for billing is handled by the driver, who gives it to the dispatcher, who then gives it to the Transit Administrator. Because the reporting function requires a significant amount of work (OTA has to submit approximately 175 invoices per month), OTA has one full-time employee solely committed to this task. The agency hopes the system will eventually allow drivers to key information about each trip into the MDT. The system will match the trip information (including the name of the individual taking the trip) with the funding program and then compile the information for invoicing purposes. Thus, the reporting function will be handled primarily by the system and much of the existing paperwork will be eliminated.

6.5.6 Staff and End-User Reactions

Drivers appear to like the technology when it is working. While there was some feeling among drivers that the AVL system allows dispatchers to look over their shoulders, the drivers appreciate that there is a positive side to this as well, since the system has been used to resolve customer complaints in drivers' favor.

Drivers expressed that, when it is working, the MDT text messaging is a significant improvement over the radios and that it substantially cuts the need for voice traffic. As discussed above, drivers and dispatchers have lost confidence in the messaging system and therefore use their radios or cell telephones if an important situation arises. Drivers also identified the need for a louder audio notification when a message is received in the vehicle since they sometimes miss the notification if they are outside of the vehicle. One disadvantage of the text messaging is that drivers have to pull over to key in a message since the canned messages are not often used. Drivers also like the pre-trip inspection since there are no forms to fill out, although, as stated previously, not all drivers are using this feature because they do not have confidence that the reports are being transmitted.

Additionally, drivers like the safety features of the AVL system. They specifically like the fact that dispatchers know their locations in the case of an emergency and that they have the emergency “panic” button. Although the panic feature has not been needed to date (and has only been triggered inadvertently), the emergency alarms still add a sense of security for the drivers.

Dispatchers also expressed that they like the AVL/MDT technology when it works properly. They like the ability to see where a vehicle is at any point in time, which helps them better schedule same-day trip requests. They also like the ability to use text messaging because they can relay information without broadcasting throughout the whole radio system, an issue that is particularly relevant to the transmittal of confidential information. However, the dispatchers have also lost confidence in the text messaging system and generally rely on the radio system for communication.

6.6 Project Costs and Revenue Sources

6.6.1 Costs

The entire project cost was approximately $628,000. However, this figure includes a number of items that are not yet fully installed and paid for. For example, the scheduling and dispatch system has been installed but was not working as of February 2002. The overall project costs include the following:

RSI

- In- Vehicle Equipment (AVL, MDTs, Emergency Buttons) $114,090
- AVL Tracking and Display Workstation 67,250
- Data Communications Link 35,800
- Installation/Training/Maintenance 20,750
- Total for RSI $237,890

StrataGen[30]

• Scheduling/Dispatch System	$43,900
• MDT/AVL System Integration	7,000
• Training in ADEPT Software	5,000
• Travel	4,000
• Total for Scheduling/Dispatch and Integration	$59,900

Project Management

• Carl Thornblad, Consulting Project Manager	$58,522

Communications Equipment

• Radios, fixed facilities equipment, base station	$213,433
Total Cost	**$569,745**

6.6.2 Revenue Sources

OTA received an FTA demonstration project grant to help fund the project. In addition, Iowa DOT provided a portion of the non-federal match on the project. OTA provided the remainder of the match and later some additional and unanticipated funds to cover costs in excess of the original project budget. A significant portion of the unanticipated funds were used to pay the consulting Project Manager.

• FTA (Section 3)	$433,218
• Iowa DOT	50,000
• Local (match and additional local funds)	89,587
Total Revenue	**$572,805**[31]

6.7 Considerations/Best Practices

6.7.1 The Planning Process

As discussed earlier, OTA did not conduct much pre-project planning for their ITS deployment. Very little needs assessment was conducted by agency's contractors in developing the specifications and implementing the project. OTA feels that more initial planning would have been beneficial, especially in detailing the overall objectives into functional specifications. The agency did find that using the Peer-to-Peer program helped tremendously in both the planning and procurement processes.

[30] This includes the ADEPT 2.3 Site License (up to 10 workstations), one ArcView GIS Site License, reporting and billing customization, MDT/AVL integration components, and training. The cost of annual maintenance after the first year was $4,000 for standard support (normal office hours on weekdays) with extended support ranging from $100 to 150 per hour.

[31] Note: Costs and revenues are not exactly the same because there is still a slight balance left on OTA's grant.

6.7.2 The Procurement Process

Because the agency had to procure each piece of the ITS project separately, the procurement stage was fairly lengthy. Additionally, while this separate procurement process may have ultimately minimized the cost of the project, it may have had an impact on the contractors being able to meet the specifications provided and may have contributed to some of the integration problems currently facing the agency.

The Administrator at OTA expressed that she hadn't realized the number of resources, vendors, and products available for the type of application they were implementing. While being able to learn from this pool of resources can be beneficial to the agency, it can also make the procurement process complicated and difficult. After several initial attempts, OTA found that using a hybrid of technical and functional specifications in the RFP was the best way to get responsive bids that were within their budget.

Finally, OTA has had some problems in the implementation stage of their ITS deployment, primarily stemming from difficulties with their contractors. The agency feels that they should have written more performance-based contracts with their vendors in order to avoid the types of problems they have encountered. This is an important consideration for other agencies considering such an ITS deployment and shows that careful thought and planning in the pre-deployment stages can greatly improve the outcome of later project stages.

6.7.3 The Installation Process

As stated above, OTA staff indicated that the procurement, installation, and system integration were made more difficult because each component of the system had to be purchased and installed separately. However, in general, installation of the communications and AVL systems was relatively straightforward (the installation took four months). The agency used an outside ITS Project Manager to monitor the vendor. The project manager spent considerable time on-site. The agency felt that the consultant was especially helpful because he was detail oriented. However, there were times when the Transit Administrator was not always included in the decision making process that involved the project manager and the vendors. While using outside consultants can undoubtedly be beneficial to ITS deployments, agencies should make sure that the key agency staff continue to be involved in the deployment.

OTA staff felt that the project would have benefited from having a clearer testing protocol and an incremental start-up that included some beta testing. In order to minimize installation costs, equipment was installed in vehicles all at once. Installation did not include any rigorous testing requirements. Revisions to the system have been made over time, but the de-bugging process negatively affects OTA operations since OTA has to bring all 51 vehicles into the facility for modifications. OTA's experience points to the importance of having a solid beta testing and acceptance testing protocol in place when implementing any ITS project. If the system does not work correctly, operations can be negatively impacted and staff begin to lose confidence in the system.

The OTA case study also emphasizes the importance of sufficient training in any ITS deployment. Both the dispatchers and drivers at OTA feel that they have not received adequate training. Since dispatchers do not have time to experiment with the system, they feel they are not using it to its full potential. OTA feels that they should have been more insistent about the training of their personnel by their vendors. Furthermore, dispatchers reported that when the vendor makes software changes, the user interface can sometimes change enough that certain features must be relearned. However, the vendor does not provide documentation of these changes, thereby making the learning curve steeper for the dispatchers.

6.7.4 Operations

As mentioned previously, a number of features of OTA's system were not yet working properly as of February 2002, so final payment to the vendors has not been made. OTA's experience points to the importance of preparing comprehensive functional requirements and specifications, then closely monitoring the vendors and developing a good working relationship with them. Additionally, OTA regrets not having a specified protocol for tracking system problems, reporting them to the vendor, getting them fixed, and then signing off that they have been adequately fixed. This has been a significant problem for OTA, and emphasizes the importance of developing such a protocol for this type of project.

A strong communications backbone is required for the system, including both good coverage and ability to communicate both voice and data simultaneously. OTA was able to build a comprehensive communications backbone using existing tower resources to keep costs down. Other agencies looking at implementing similar systems should look for opportunities like this one, but should also keep in mind that the system is likely to be demanding, as evidenced by OTA's ongoing communications problems. While OTA was able to utilize existing resources, minimal radio coverage analysis was done to establish how the new radio system would handle the capacity demands of voice, text messaging, and GPS data communications. This has resulted in numerous problems for OTA and should be kept in mind by other agencies deploying similar technologies.

Additionally, some of the equipment used in OTA's ITS deployment needs to be uninstalled and sent to the vendor when problems occur. This procedure negatively affects the agency's operations, particularly if the lag time in getting the piece of equipment fixed is lengthy. When looking at purchasing equipment for an ITS deployment, agencies should look carefully at the procedure necessary for maintenance and upgrades, paying particular attention to the effect they will have on everyday operations. If repairs of equipment are expected to be lengthy, appropriate provision of spare parts should be considered.

6.7.5 Other Considerations

In addition to the considerations mentioned in the above paragraphs, the Ottumwa case study pointed out a number of other issues that should be of concern to agencies considering implementation of a rural ITS application.

- OTA’s Transit Administrator eventually had the AVL/MDT software installed on her computer. She thinks this has been beneficial since she now understands the problems that the dispatchers are having with the system.
- OTA has no Information Technology (IT) support and the City is not in a position to provide this support. Therefore, the Transit Administrator has had to rely on the vendors for support, which has

not been sufficient. The outside project manager suggested that IT support be provided by Iowa DOT for all Iowa transit systems needing such support, but to date this has not occurred. A consideration for other agencies is to think about developing some in-house technological expertise if it does not already exist, so that the agency is not entirely reliant on vendors for IT support. If it is not possible to develop the expertise in-house, the agency should consider partnering with other agencies for such support or requesting it from higher-level agencies (such as state agencies).

- It can be difficult for experienced staff to modify their behavior to use new systems and data. For example, at OTA, it is questionable whether the level of training for staff has been related to some of the issues the agency has faced with its ITS deployment.

6.7.6 Overall Assessment

Overall, the system has met many of OTA's original project goals, but has also fallen short in a number of areas, as described below.

Goal 1: Communicate with all vehicles

This goal is being met to some extent. The MDT text messaging, when working properly, allows dispatchers to communicate with all drivers, even in the most remote areas. Text messaging eliminates the need for voice communications, keeps conversations private, and results in less over-the-radio chatter. However, as of February 2002, the text messaging was not reliable, so drivers and dispatchers lost confidence in it and reverted back to using radios and cell phones.

Goal 2: Locate and track vehicles in the service area

This goal is being met well. The AVL allows dispatchers to locate and map the location of all vehicles in the system.

Goal 3: Improve safety and security of the system vehicles, drivers, and passengers

This goal is being met. The dispatchers know where the vehicles are and can respond more quickly to incidents. The drivers feel better connected in case of an emergency. The emergency buttons work well, but given the number of "false alarms" the agency may want to investigate better methods for securing the panic buttons.

Goal 4: Communicate maintenance problems and pre-trip inspection reports directly to the base

This goal is being met well. The MDTs allow the drivers to complete and transmit the pre-trip inspection form. However, as of February 2002, the recently purchased maintenance software had not yet been integrated with the AVL/MDT system.

Goal 5: Facilitate the agency's billing process

This goal is not being met. Since the scheduling and dispatch portion of the software (including the billing module) has never been properly implemented, invoicing individual agencies by OTA has not improved as originally planned.

6.7.7 Unexpected Benefits

The implementation of the system has also had a number of unanticipated benefits for OTA, as follows.

Better control over driver pay hours

One of the most significant benefits of the system has been management's ability to track drivers using both the AVL and the log-on/log-off feature of the MDTs. The system helps the Transit Administrator better manage drivers' time and pay hours. She can compare driver time sheets with log on/off records as well as the path of the vehicle and dwell times.

Better customer service

Many of the customer service benefits are intangible. Nonetheless, OTA feels that it is providing better service for its riders. For example, if the AVL is working effectively, the system is able to better manage same day trips, which benefits customers who are trying to schedule those trips. The AVL system also allows office staff to print maps for new or re-assigned drivers, answer customer complaints and inquiries, and give drivers directions, all of which result in better customer service for OTA riders.

Resolution of customer/driver disputes

The vehicle activity reports provided by the AVL/MDT system allows OTA to better respond to customer complaints and more easily resolve disputes between customers and drivers by tracking the exact time at which a vehicle arrived at each location along its route.

Better tracking of schedule adherence

The system also has the ability to produce schedule adherence reports, which help management track driver performance and better manage operations.

Better vehicle scheduling/management

The pre-trip report from the AVL allows the staff to do better "load balancing" by helping them assign vehicles in a way that balances their mileage and useful life. OTA rotates vehicles to ensure that all vehicles of the same vintage have similar mileage. The AVL reports allows dispatchers to better match vehicles with manifests by providing information about the vehicle's age, its mileage, the route length, operating conditions along the route, and the passengers. Additionally, the system allows office staff to print vehicle activity reports, which can also help with vehicle scheduling and management.

6.8 Future Plans

At this point, OTA is working to get the system fully up and running. Their highest priority is the AVL and messaging system, which is close to working but not yet completely functional. The next priority is to get the scheduling and dispatch system working correctly and to then integrate the two systems.

7.1 Case Study Overview

Operated by the Williamsport Bureau of Transportation, River Valley Transit provides fixed route and demand responsive services in the greater Williamsport, Pennsylvania area and surrounding Lycoming County. The Bureau recently completed construction of a new intermodal center and, in the process, implemented a system to provide real-time customer information for routes operating out of the transit center. The technology:

- Allows the agency to inform customers both visually and audibly as to which of the 10 loading bays buses will arrive at and depart from;
- Gives customers a 20-second notification before buses depart the terminal;
- Notifies drivers when they have pulled into the wrong bus bay; and
- Allows the agency to create reports that can be used for operations and planning purposes.

The application is remarkable because it is an example of a technology solution that was developed to deal with a somewhat unique problem encountered by the agency. River Valley Transit's Traveler Information System (TIS) provides a simple, automated way to direct passengers in a transportation center to the correct bus bay, which is sometimes difficult to determine. The project has been tremendously successful and recently won second place in the state's technology achievement awards showcase.

7.1.1 Williamsport Transit System Overview

River Valley Transit provides both fixed route and demand responsive services in the greater Williamsport area and surrounding Lycoming County.[32] The City of Williamsport covers approximately 9 square miles with a 1990 population of almost 31,000 persons. During Fiscal Year 1999, River Valley Transit (called City Bus at the time) provided over one million passenger trips on its fixed route system. River Valley Transit has thirteen fixed routes, most of which are operated out of the McDade Trade & Transit Centre building. The transit center has an information window in the lobby, where passengers can obtain information and purchase fare media. Approximately 94% of trips taken on

All 28 of River Valley Transit's fixed route buses are equipped with the TIS.

[32] Lycoming County, the largest county in Pennsylvania, covers 1,235 square miles and has a 2000 population of over 120,000 people. The County has a population density of 97 persons per square mile.

River Valley Transit's system flow through the transit center.

River Valley Transit is operated by River Valley Transportation Services, which is part of the Williamsport Bureau of Transportation (WBT). WBT is a City department with responsibility for a number of functions in addition to operating River Valley Transit, including management of parking facilities and operation of a ferryboat, trolley services, and charters/tours. The transit system has 28 vehicles in operation and 33 drivers. Dispatchers and other operating personnel are located at the River Valley Transit headquarters, which is also the location of the agency's maintenance garage. Customer information specialists are located at the downtown transit center.

7.1.2 Williamsport Case Study Field Work

The research team conducted a site visit in Williamsport on February 19 and 20, 2002 in order to learn more about their Traveler Information System (TIS). During the site visit, the team interviewed the following individuals:

- William Nichols, Jr., General Manager;
- Kevin Kilpatrick, Planning Manager; and
- John Kiehl, Operations Manager.

The team also visited the downtown transit/information center, talked with drivers and mechanics, interviewed and observed dispatchers and information clerks, and spoke with passengers using the TIS.

7.2 Project/System Background and History

The TIS project was initiated as a small part of the McDade Trade & Transit Centre Project, which included the following elements:

- Construction of the McDade Trade & Transit Centre building;
- Construction of the adjacent L.L. Stearns & Sons Plaza, which includes shelters for bus passengers;
- Renovations and streetscape enhancements on two local streets; and
- Construction of a new parking garage.

The L.L. Stearns & Sons Plaza, which is part of the Trade & Transit Centre Project, has covered shelters for bus riders.

The Trade & Transit Centre was in the planning and construction phases from 1996 to 1999 and was dedicated in December 1999. The primary goals in building the transit center were to streamline transit operations in the downtown area, make River Valley Transit more accessible and convenient for riders, improve traffic and pedestrian circulation in the Central Business District, and stimulate economic development in the downtown area. The Trade & Transit Centre provides a centralized transfer point for all River Valley Transit routes operating in Downtown Williamsport. The entire project cost was $13.2 million and the project was funded by the City of Williamsport, Lycoming County Government, the Williamsport Parking Authority (WPA), the Pennsylvania Department of Transportation (Penn DOT), and the Federal Transit Administration (FTA).

While the Plaza and transit center clearly improved conditions for River Valley Transit passengers, they also presented the WBT with some major challenges. Because the transit center was located in the heart of the downtown area, there were physical space limitations that required specific traffic flow patterns. The River Valley Transit system is a pulsed system; therefore, a number of buses were coming into the transit center at the same time. Since it was not possible to assign each route to a unique bus bay, vehicles were required to come into the transit center and park on a "first-in, first-out" basis. Consequently, there existed the potential for riders to become confused as to which bus they should be boarding and where that bus was located. The transit center planners needed to lessen this confusion by providing better information to bus passengers. Thus, the state-of-the-art TIS was designed to assist riders in finding their respective buses by directing riders to the correct bus stop within the transit center using technology.

The transit center project was being overseen by a general contractor, Wilbur Smith Associates. The TIS ultimately became part of the electrical contract, which was the responsibility of Lecee, a subcontractor to Wilbur Smith. Avail was selected as the contractor responsible for the TIS under contract to Lecee. The RFP for the procurement of the TIS system was issued in July 1998 and awarded in October of that year. The TIS was installed on all buses and tested in October-November 1999. The system was fully installed by January 2000 and fully operational by April of that year.

7.3 Project Goals and Objectives

7.3.1 Stakeholders

The TIS project had a number of stakeholders, including the following:

- The SEDA-Council of Governments (SEDA-COG);
- The City Council;
- WBT/River Valley Transit staff;
  - General Manager;
  - Planner;
  - Operations Manager;
  - Dispatchers/Drivers;
- River Valley Transit riders;
- Vendors:
  - Avail (equipment vendor and integrator);
  - Lecee (electrical contractor);

- Wilbur Smith (original architect/engineers for the project);

Additionally, the WBT formed an Americans with Disabilities (ADA) committee, which helps address any issues that arise regarding accommodations for individuals with disabilities.

7.3.2 Goals and Objectives

As the project was being conceived, the WBT's primary goal was *to allow riders at the transit center to locate their respective buses in a safe, convenient manner*. During the planning process, the staff added the goal of generating data that would help them better manage operations. Specific goals for the project included:

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

7.4 Description of the Application and Technology

7.4.1 General TIS Characteristics

The central focus of River Valley Transit's ITS deployment was the use of the TIS for customer information at their transit center. The TIS contains both dynamic signage and audio information that helps transit riders identify the location of their desired bus route. The dynamic signs were modeled after those seen in airports because the agency knew that customers would generally be familiar with that format. Information on the signs and in the audio messages utilizes data received from mobile data terminals (MDTs), which are installed in all 28 of the agency's vehicles.

Variable message signs show buses in the terminal and their bus bay locations.

When drivers arrive at the transit center, they use the MDT to indicate that they have entered the terminal, as well as what their stop and route numbers are. Drivers are instructed to stop their buses before entering data, but often enter data on the street once they are in range of the transit center. The data is then sent to the base control computer in the transit center via a wireless local area network (LAN) modem. The data is stored in a database for future analysis, as well as used to build visual and audible messages. The text messages are displayed on signs inside and outside of the bus, and in corresponding audio messages that are broadcast over the PA system. Drivers have the ability to revise information if an error occurs or if they use a different bus bay than the one originally indicated. Announcements over the PA system include the bus route and the bus stop location, and are repeated every minute while the bus is in the terminal.

When the driver is ready to leave the terminal, he/she selects the "End Terminal" button on the MDT. The system changes the announcements, causing the name of the route to flash on the message signs for 30 seconds. The system then informs the driver that he/she is free to leave the terminal after a user-specified delay has been met.[33]

While the primary objective of developing the TIS was to improve customer information for River Valley Transit riders, the system also has a number of features that aid in operation of the bus system. In many cases, the additional functionality was added after the initial project specifications had been completed. Some of the additional operational features of the TIS are:

- Each vehicle's MDT has a clock display that is synchronized every time the vehicle enters the terminal, thereby providing drivers with the accurate time.
- The application includes signal prioritization for buses at the traffic signals leading into the center.
- The MDTs inform drivers when communication with the base computer has been disrupted. This is a one-way transmission that displays a message to the driver in the event that any message he/she sends is not explicitly acknowledged by the base.
- Instructions for drivers on MDT data entry are provided.
- Remote informational displays are available to operational staff at the transit center and at dispatching and supervisor offices at the Garage and Office Facility. The displays provide operations and management personnel with a real-time view of current activity at the transit center.
- Documentation of actual arrival and departure times of each bus are provided by the system.
- Remote terminal capability is available.
- The base control center receives a ping message whenever a bus is in the vicinity, thereby allowing dispatchers to hold vehicles at the transfer point for a short period of time if they know that another vehicle is in range.

Drivers are provided with data entry instructions for the Mobile Data Terminals.

[33] River Valley Transit currently has this delay set to one minute.

Use of the system to track and monitor schedule adherence is also functionality that was not initially conceived, but was added prior to installation. The system generates a number of reports that are useful for planning purposes, including:

- **Daily Trip Exception Report** – Reports when buses entered or exited the center without the driver entering the "enter terminal" or "end terminal" commands on the MDT, indicating that drivers were having problems with the system or failed to enter the data.
- **Daily Error Log Report** – Reports error time, bus ID number, and error text. Errors are recorded when there is a failure to communicate with the sign, or when a bus arrives or departs without the driver hitting "enter terminal" or "end terminal".
- **Daily Schedule Adherence Report** – Reports time, bus number, scheduled arrival and departure times and deviations from the scheduled times (in minutes). This report is used by the operations manager to track late or early arrivals and by the operations planner to assist in periodically revising routes.
- **Daily Revise Usage Report** - Reports instances when the driver used the "Revise Terminal" button, indicating that he/she used a different terminal that the one originally intended.
- **Off-Duty Report** - This is an exception report that lists all buses that made no trips during the report period. The user can review trip exceptions either for a given day or an entire week.

7.4.2 Technological Components of the TIS

The TIS application includes the following components:

- **MDT Units**: Text-based MDTs are installed in all of River Valley Transit's fixed route vehicles. The purpose of the MDT units is to provide an easy way for drivers to enter information into the system. The vendor for these units was Mentor Express.
- **Base Control (Server) Computer:** PC located at the transit center, which functions as the Base for the TIS. The computer is equipped with a 56K modem for communications.

MDT units are installed in all 28 of River Valley Transit's vehicles. The agency purchased an additional MDT in case one breaks down.

- **Client Computers:** Originally, the plan was to have only one computer at the Base. However, River Valley Transit requested the addition of remote terminal capability so that the customer information specialists at the transit center and operations personnel at the River Valley Transit offices could access information in the TIS. Communication between the base control computer and the remote site computer takes place via the Local Area Network (LAN).

The RF Communications Units allow messages to be transferred between the MDTs and the Base computer.

- **RF Communications Units:** The RF communications units allow messages to be transferred between the MDTs on the vehicles and the Base computer. The units are Proxim RangeLAN2 7910 series serial adapters. Communication occurs via a 2.4 GHz Spread Spectrum wireless LAN.
- **Routers/modems:** A router/modem solution was implemented to ease communication between the Base and the remote sites, minimizing the cost of communications as compared to using a leased line.
- **Base Control Unit Software**: The Base Control Unit software operates on the base control computer. It accepts and routes the messages from the MDTs to the Sign and PA Control Units (see below). It also keeps a log of all messages, stores messages in a database, provides an error log, and provides a manual interface for overriding messages from the MDTs.
- **Signs Control Unit Software:** The Signs Control Unit software also runs on the base control computer. The unit receives information from the Base Control Unit and places the route name on the appropriate bus bay sign in the transit center.
- **PA Control Unit Software:** The PA Control Unit software runs on the base control computer as well. This unit has a number of pre-determined audio messages from which it selects when information has been received from the Base Control Unit.
- **Bus stop display signs and public address system**: These components are installed at the transit center and are used to convey information from the TIS to the public.

Avail Technologies, Inc. provided software, integration, wireless communications (including MDTs), the central computer, and the signs. Avail Technologies populated the TIS database with route information including the scheduled arrival and departure times at the transit center. Lecee Electrical Contractor provided power and cabling for the message signs and the public announcement system.

As mentioned previously, the project also included signal prioritization at the transit center. As buses leave the center, they trigger a “loop switch” embedded in the ground that keeps the traffic signal green an extra 17 seconds.

7.5 Design, Operations, And Performance

7.5.1 System Design

Avail worked closely with the River Valley Transit when designing the TIS in order to make sure the system met the agency's needs. A Preliminary Design Review (PDR) was conducted on February 15, 1999. The PDR outlined the system overview, Avail’s plans for installation and testing, and the project schedule. The purpose of the PDR was to obtain River Valley Transit's feedback and approval for the system design. As a result of the PDR, a number of system enhancements were proposed.

Additionally, River Valley Transit worked closely with the regional Metropolitan Planning Organization, the SEDA-Council of Governments (SEDA-COG), to ensure that they were meeting any needs that SEDA-COG might have of the TIS.

7.5.2 Training

As part of the TIS project, Avail conducted training at the Trade & Transit Centre for the following personnel:

- Operations and Maintenance personnel;
- Supervisors; and
- Bus Operators.

Bus operators received four hours of training, and mechanics and operations personnel attended a one-day training course. In speaking with drivers and mechanics at River Valley Transit, it was evident that the training was sufficient for them to feel comfortable with the new system. Additionally, a few weeks prior to installation, Avail set up a sample MDT in the driver's room so that bus operators could try it out and become comfortable with it.

The contract with the vendor also required that a number of specific documents be provided to River Valley Transit. Avail provided the following documentation as part of the TIS project:

- System Component Descriptions;
- Maintenance and Service Documentation;
- Operations and Maintenance Manuals;
- Manual for Bus Operators;
- Systems Administration Operations Manual; and
- Communications Protocol Manual.

7.5.3 Maintenance of the TIS

Originally, the system had a one-year warranty, which began at the end of the acceptance-testing phase. However, long-term system maintenance was to be the responsibility of River Valley Transit staff. Avail provided the agency with a TIS *Operations and Maintenance Manual* and provided one day of maintenance training for River Valley Transit mechanics, who have now taken over maintenance of most of the equipment. Maintenance staff at River Valley Transit indicated that the training was sufficient in helping them take over the long-term system maintenance.

Avail now provides maintenance support on an annual basis. The current maintenance support contract includes extended system support for one year and a one-year hardware warranty, which are offered to

River Valley Transit at a cost of $7,500. The system support includes both on-site and phone/remote diagnostic system support. The hardware warranty covers all of the TIS products provided by Avail and includes on-site repair for items that River Valley Transit is not responsible for maintaining, including the server computer and the variable message signs.

7.5.4 Operational and Other Challenges

River Valley Transit has had some issues with its radio system, although these problems are not directly related to the TIS since TIS communication occurs on a different frequency. When the TIS project was initiated, the City had an 800 MHz license. Since then, the City replaced its 800 MHz trunked radio system with new repeaters in the 150 MHz frequency band. In the process, River Valley Transit was assigned one frequency. While the radio equipment being used by River Valley Transit is adequate, the frequency and power are not sufficient to handle the AVL system. The WBT operates one repeater and experiences poor coverage. Since River Valley Transit has only one frequency, the AVL on the radios was shut down because it interfered with radio voice communications. The City hired a radio consultant that is working to correct this problem as of March 2002. River Valley Transit feels that they need to move the location of the repeater and add a second repeater to accommodate the AVL.

As stated previously, communication for the TIS occurs via a 2.4 GHz Spread Spectrum wireless LAN. The system consists of mobile transponders in the vehicles and three fixed transceivers in the transit center. One challenge faced by River Valley Transit was deciding where to locate the fixed transceivers, since there had to be a balance between their location and their power output.

The agency has also initially had some problems with data management. Partway through the deployment, River Valley Transit recognized that there was an abundance of data being captured by the system and that this data could be used for planning and operations purposes. However, the amount of data being produced was somewhat overwhelming, and they subsequently had to develop a data management plan. The plan involved deciding which performance measures would be tracked and then asking Avail to incorporate report generation software into the system. Reports can be generated with the use of Crystal Reports software, although as of February 2002 staff had not yet been trained in using this tool.

7.5.5 Perceived Benefits of the TIS

The TIS clearly has a number of benefits, from the perspectives of both River Valley Transit's customers and the agency itself. The system helps the agency provide better customer service by directing riders to their buses, thereby eliminating some of the confusion associated with the first-in, first-out system. Since customers are supplied with better information, fewer inquiries are directed to transit center staff. Since the operations people at the agency are being provided with better operations data, they can better manage customer complaints and are able to revise the bus schedules based on information they receive from the TIS reports. Additionally, the visual and audio announcements can be especially helpful for individuals with disabilities.

7.5.6 Staff and End-User Reactions

Both drivers and riders appear to have had a positive reaction to the technology. Drivers find the MDTs easy to use and appreciate that the system helps riders locate their buses. Drivers especially appreciate the standardized route codes for the headsigns, MDTs, and bus annunciators. In general, riders appear to like the signs because they provide easily accessible information. In particular, the audible announcements over the PA system are especially helpful for persons with vision impairments.

7.6 Project Costs and Revenue Sources

7.6.1 Costs

The entire TIS project cost was $200,000, including the cost of signs, in-vehicle equipment, computers/workstations, servers, software, installation, integration, and warranty. The original estimate was approximately $150,000, so additional funds were obtained for enhancements and upgrades.[34]

7.6.2 Revenue Sources

The WBT received a capital grant from the FTA to build the transit center, which covered 80% of the $13.2 million cost. Penn DOT, the City, and the County each provided a portion of the non-federal match for the project. The $13.2 million contract included contingency funds, which funded the TIS project. Therefore, the project did not need to compete with other ITS projects for funds and was developed specifically as a piece of the larger transit center project.

7.7 Considerations/Best Practices

7.7.1 The Planning Process

The idea for the TIS project was developed as part of the overall transit center planning process. The architectural/engineering general contractor, Wilbur Smith, developed the functional specifications as a way to solve the bus staging/space constraint issue. No other planning was conducted for the TIS project prior to the procurement stage. In other words, WBT did not fully design the system up-front. Rather, the specifications gave the vendor the concept of what the agency wanted and challenged the vendor to design the system. This model may have resulted in lower costs because River Valley Transit did not have to pay the engineers/architects to design the TIS.

Once Avail was selected, the vendor held a work session with agency staff to define the characteristics of the system and to suggest additional ways in which the technology might be used to manage operations. Avail then developed the technical approach based on staff input. River Valley Transit staff were able to enter into a creative design/work session with the vendor that resulted in a product that provided the best possible solution to several issues. An important lesson learned during this process was that such a work session should include everyone involved in the project, including managers, planners, dispatchers, mechanics, and drivers. By including all of the departments that may be affected by the technology, the agency can better ensure that all of the stakeholders' needs are being met.

[34] The in-vehicle equipment, including MDTs, was approximately $2,400 per vehicle.

7.7.2 The Procurement Process

The City procured the TIS as part of the bid solicitation for the transit center. The TIS component was included in the requirements for the electrical contractor, who was a sub-contractor of the general contractor, Wilbur Smith. The city had a very good relationship with the electrical contractor, Lecee, who proposed using Avail as a subcontractor for the TIS. The process for developing the TIS was to be "design, build, and maintain". In other words, the contractor was responsible for all aspects of the system, although some preliminary functional design work for the TIS had already been done by Wilbur Smith.

Although Avail was brought into the project as a subcontractor to Lecee, River Valley Transit staff ultimately worked directly with Avail. Had this been a separate procurement, the City would have had to bring in an outside consultant to help them with the procurement.

7.7.3 The Installation Process

Avail installed the equipment and made sure that it interfaced and was compatible with River Valley Transit's existing network. Avail first installed the equipment on one vehicle, and then placed this vehicle back into service as part of a vehicle acceptance test procedure. This process is referred to as prototyping. Once the vehicle acceptance test was successfully completed, installation was done on the remaining vehicles in the fleet. Avail was also responsible for full functional testing on all vehicles, signs, and the public address system. One of the keys to the successful installation of the project was that equipment was installed, tested, and problems were corrected before the center opened and the TIS was fully on-line.

After all of the components were installed, a final acceptance test was conducted by Avail and River Valley Transit. As part of Avail's end-to-end solution, River Valley Transit staff were invited to the Avail offices to witness the operation of the system. Avail and River Valley Transit staff also conducted a 30-day equipment operations test, which involved the generation of Discrepancy Reports by transit staff. The operational test resulted in the correction of a number of problems with the system. In addition, Avail received a handful of canned recordings for the PA system, which were completely integrated and tested until the agency was satisfied with the quality before the remainder of the messages were installed.

Problems that were resolved during the testing phase included:

- River Valley Transit staff realized that they had underestimated the number of messages they would need and had requested of the vendor. The original proposal included recorded messages for 30 routes, which resulted in 900 different messages.[35] River Valley Transit started the process with a "long list" of 115 routes[36], then developed a "short list" of 64 routes, and finally developed a "very short list" of 31 routes. The decision was made to record enough messages for the routes on the

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[35] Every route needs 30 recorded messages. For each route, there is an arrival, status, and departure message (3 total) and ten possible stops that the bus could pull into (3 messages x 10 potential stops =30 messages).

[36] Even though the system has only 10-13 routes that use the downtown transit center, an individual route may have multiple names depending on what each run does. For example, the East End Route may need messages for the East End/Manor Care route and the East End/Eldred Street Route. Each of these has to have its own recorded messages.

short list, leaving River Valley Transit to cover extra cost. Avail negotiated a fixed price per route with the local recording studio ($35 per route) for an extra cost of $1,190.

- River Valley Transit staff decided that it was taking too long to generate reports remotely because of the speed of their communications connection. They fixed this problem by adding an integrated Modem/Router to provide TCP/IP connectivity and extend their LAN from to the River Valley Transit office to the transit center using a standard phone line connection. This solution turned out to be more cost effective than leasing a dedicated line for communications.
- River Valley Transit staff requested, and Avail provided, two additional columns to the schedule adherence report, one for the actual arrival time and one for the actual departure time of buses.
- Additional signal transmission equipment was needed on-site at the transit center. Based on tests conducted at the center on a few vehicles, it was assumed that the signal coverage would be adequate. When operations began, with multiple buses on site, the City found that the signal was not sufficient. The problem was corrected by adding a third access point in the transit center's café for additional coverage.

In order to speed up the communications network, River Valley Transit added an integrated Modem/Router to extend their LAN.

River Valley Transit's experience during the installation phase points out a number of considerations for other agencies implementing rural ITS applications. Throughout installation of the system, the agency worked closely with the vendor. In fact, specific staff at Avail were identified to work with the agency on different parts of the system. For example, Avail put the agency in contact with a specific individual who worked with them on the PA system interfacing issues. River Valley Transit's experience emphasizes that agency staff need to develop a good working relationship with their vendors and stay on top of the project at all times. Additionally, it is important for the agency to have a clearly defined acceptance/sign-off procedure in place with the vendor so that major project milestones are achieved.

River Valley Transit's experience highlights the importance of thorough system testing prior to implementation. Prior to mounting hardware on the vehicles, Avail conducted a vehicle site survey to make sure there wouldn't be an mounting problems. Vehicle equipment was fully tested before being put back into circulation. At the vendor's suggestion, the agency conducted both a Final Acceptance Test and an Operational Test of the equipment once it was installed. A few weeks prior to installation, Avail set up a sample MDT in the driver's room so that bus operators could try it out and become familiar with it. The fact that the TIS was tested completely before it was brought on-line ensured that it would not have any major problems during implementation. Since the primary purpose of the system is to direct customers to the correct bus bays, it was important that the system work correctly so as not to confuse riders.

7.7.4 Operations

River Valley Transit has and continues to use a formal process to document problems in writing using Problem Identification Reports. These 4-page forms are used to quickly identify problems so that they can be resolved in a timely manner. Problem Identification Reports can be filed by any employee using the system, including maintenance and operations personnel, and include requests for the following information:

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

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

Avail has been providing phone support to answer operational questions and, based on the formal master list of problems, has met with River Valley Transit to review the list one-by-one and discuss how issues can be resolved. Once a solution is implemented, Avail meets with the River Valley Transit staff to demonstrate the new features. An example of a correction since installation was that drivers were able to turn the MDTs off. Consequently, Avail reprogrammed the units so that the on-off switch is no longer functional. They have been able to continue providing customized support to River Valley Transit. The on-going problem identification and communication between River Valley Transit and Avail is an example of a good relationship that should exist between the agency and the vendor. This relationship has been key to the success of the TIS project and is evidence that agencies should pay specific attention to the vendor's ability to provide on-going support and to be responsive to the agency's needs.

7.7.5 Other Considerations

In addition to the considerations presented in previous paragraphs, the River Valley Transit case study revealed a number of other lessons learned, as described below.

- In this case, the agency found that building a customized system worked better than trying to adapt a commercial, off-the shelf product. The agency developed a simple technological solution that was built to deal with a specific need. Other agencies considering ITS solutions should look carefully at what they need and not rule out the possibility of building a low-cost, simple solution that meets the agency's specific needs.

- It is important for someone in the organization to be able to engage in "technology talk" so that control is not given up to the "techies", particularly if the technical people are vendors rather than agency staff.
- Although the technology implementation was being done by a vendor, it still involved a significant level of effort and on-going management at the agency level. Other agencies considering ITS solutions should bear in mind that a high level of effort will be necessary in order to manage the project and to keep it on schedule and within budget.
- Often, the personnel who will be using the system, such as bus drivers, are somewhat averse to trying out new technology. Therefore, training these personnel is key and it is important to get them to "buy into" the system.
- River Valley Transit realized fairly quickly that the TIS system generates many pages of data per day and that it is impossible to utilize all of the data produced. Staff were experiencing "information overload," so it was important for the managers to prioritize the information being collected and identify which performance measures would be used to evaluate the service. Once they had done this, they incorporated a reporting module into their contract. Data management is something that should be carefully considered in the implementation of any ITS project.
- One of the recommendations made by Avail to River Valley Transit was that they should purchase a spare MDT in case one of the regularly used units were to malfunction. This is an important best practice that should be kept in mind by other systems implementing technology solutions since it ensures that equipment breakdowns and malfunctions do not disrupt operations.
- Although the Williamsport TIS is a highly specialized system, it has been developed with the ability to add new features. When implementing new technology, agencies should always think about how they might want to expand the system in the future and ensure that they are developing the system in a way that allows for potential future enhancements.

7.7.6 Overall Assessment

Overall, the system has met all of the River Valley Transit original project goals, as described below.

Goal 1: Develop a rider-friendly system that will allow riders to identify buses in the downtown area

This goal is being met. Riders, drivers, and dispatchers love the system of signs and announcements. The system is easy to understand and use and the equipment operation is reliable.

Goal 2: The system should have minimal requirements of the drivers

The TIS is as automated as possible, requiring only minimal input from the drivers. According to the drivers, the prompts on the MDTs are easy to use. It has not been difficult for drivers to become acquainted with the system.

Goal 3: Provide a data trail to monitor whether drivers are operating the TIS equipment properly

This goal is also being met. The Operations Manager can generate reports that indicate when procedures are not being followed, because of either driver error or system failure.

Goal 4: The system should be expandable as new technology is developed

River Valley Transit wanted a system that would be upgradeable to AVL, and the TIS does indeed have an AVL component. While the AVL is currently inoperable because it interferes with radio voice communications, it will be re-activated once the radio problem is resolved. Additionally, Avail designed the system to be easily expandable should River Valley Transit wish to add more functionality.

Goal 5: Provide the ability to monitor schedule adherence

The schedule adherence feature is being used effectively by the Operations Manager and Planner at River Valley Transit to monitor and manage the system as well as periodically re-design routes and schedules.

7.7.7 Unexpected Benefits

River Valley Transit has also discovered a number of unexpected benefits resulting from implementation of the TIS:

- The clock display on the vehicle MDT is synchronized every time the vehicle enters the terminal, thus providing a valuable tool for helping the drivers keep on-schedule.
- The agency did not anticipate the wealth of operations data that would be available from the system. The Operations Manager can use the data provided by the TIS to address customer complaints.
- Since customer information specialists at the transit center have access to some of the TIS information, they can better respond to passenger questions.
- By tracking the location of vehicles on the TIS monitors and using the "ping" functionality, dispatchers can easily hold vehicles in order to allow for transfers that otherwise might have been missed.
- The transit center and the TIS project were a critical element in successful downtown development.

7.8 Future Plans

While the TIS project has been very successful, River Valley Transit staff still have a vision of how they would like to improve the system in the future. Although the TIS application was very specialized, it was designed in a way that allows for future expansion. Potential improvements include:

- Integrate the headsigns, MDTs, and voice annunciators to simplify the system and make it more user-friendly for the drivers;

- Re-activate the AVL component of the system, which could potentially improve customer service and help in operations control;
- Develop a Web-based customer information system, which would dynamically display the real-time location of buses;
- Create other transit hubs that would have "mini" TIS applications connected to the larger TIS network; and
- Integrate an electronic farecard with the system.

Naturally, some of these enhancements are more likely to be explored in the near future than others. For example, River Valley Transit is especially interested in re-activating the AVL component of the system and integrating an electronic farecard, and will likely pursue these two expansions within the next couple of years.

Section 8 Overall Rural Transit ITS Considerations

This chapter presents the general considerations that emerged from both the initial literature review and the five case studies conducted as part of this Best Practices effort. The considerations are provided as a resource for agencies assessing the implementation of rural transit ITS. This section is organized into the following subsections:

- Use of ITS at Rural Transit Agencies;
- Institutional and Organizational Issues;
- ITS Applications and Technology;
- Funding and Other Financial Considerations;
- Rural Transit ITS Project Benefits; and
- Deployment Process Considerations.

The last category is divided into the various phases of ITS project deployment: project planning, procurement, installation and final implementation, and on-going operations.

8.1 Use of ITS at Rural Transit Agencies

8.1.1 Types of Technologies Used

A number of different types of technology have been deployed at rural transit agencies, as exhibited in the case studies. In some cases, agencies have installed and integrated multiple technological components. Table 1 summarizes the types of technologies being utilized at the five case study sites.

Most of the rural properties are using these technologies over a large service area. For example, CARTS serves nine counties in Texas, OTA serves 10 counties in Iowa, and the CRRAFT service will be used throughout the entire state of New Mexico. For the most part, the technologies at rural transit agencies are being used in a demand responsive setting. The exception among the case studies included in this report was River Valley Transit, which uses its Customer Information System for fixed route services.

8.1.2 Agency Goals for ITS

The case study participants mentioned a number of different goals for their ITS deployments. The goals mentioned most often included:

Table 1. Summary of Technologies Used by Case Study Participants

	CARTS	Florida	New Mexico	Ottumwa (IA)	River Valley Transit (PA)
Radio system	v			v	
Scheduling and dispatch software	v	v	v	v	
AVL/MDTs	v	v		v	v
Electronic farecard technology			v	v	
Customer Information Systems					v

- Improving customer service;
- Expanding the availability of service;
- Increasing efficiency of operations and administrative functions;
- Decreasing the per-trip cost;
- Improving communication between drivers and dispatchers; and
- Increasing coordination between operators.

Many of the agencies also have plans to either enhance their existing technologies, increase agency participation in their ITS programs, or to deploy new technologies in the future. Some of the future plans mentioned by the case study participants included:

- Using data collected by the new technology for planning purposes;
- Implementing electronic farecard or smart card technology;
- Integrating various ITS components;
- Adding functionality to existing software; and
- Improving the agency Web page.

8.1.3 Use of Specific Technologies

The following subsections describe some of the main points highlighted by case study participants regarding specific technologies in use at rural transit agencies.

Radio Systems

At CARTS, the new radio system allowed the agency to consolidate operations into one newly designed facility. This centralization allowed them to use their scheduling and dispatch software more efficiently and to store all of their customer information in one centralized database. Centralization also allowed them to reduce the cost of upgrading and maintaining their software.

The CARTS case study also pointed to the benefits of having a trunked radio system. Trunking involves a group of radio frequencies being managed by computer to optimize the capacity of each. One significant advantage of this type of system is that users are less likely to experience an occupied frequency and be prevented from communicating when desired.

Reservations/Scheduling/Dispatch Software

Scheduling and dispatch software packages can include a number of different modules, including vehicle scheduling and routing, staff scheduling, call intake, mapping, payroll assistance, and reporting. At the case study sites that have deployed scheduling and dispatch software, their manual systems have been converted to automated, more efficient systems. Some agencies have also managed to integrate their software systems with those at other agencies. For example, the software being used by the CTCs in Florida has been integrated with the software used by the state's Medicaid provider.

However, the case studies also indicated that schedulers and dispatchers are not always using the software to its full extent, oftentimes because they feel some functions can still be done more quickly by hand. For example, while many software packages allow for batch scheduling, schedulers often feel that, given their extensive knowledge of the system, they can perform the batch scheduling function more quickly than the software. The CARTS case study showed that agencies can encourage staff to more fully utilize the software by providing them with more training or implementing a change of procedures.

AVL/MDT Systems

AVL/MDT systems can be used for a number of different purposes, and allow drivers and dispatchers to work in a paperless environment. At the most basic level, they can help record ridership data, and give dispatchers a real-time "picture" of where the vehicles are. Thus, they can help the agency more easily track ridership and operations statistics (such as schedule adherence). Agencies such as OTA and the CTCs in Florida are taking their MDT use a step further and using them for transmission of pre-trip vehicle inspection reports. This is an especially interesting use for rural transit agencies that have vehicles and drivers spread over a geographically large area.

One of the primary functions of MDTs is typically text messaging, which can reduce the amount of radio chatter between drivers and dispatchers. However, some of the case study participants indicated that this functionality was not being heavily used. For example, in Ottumwa, the feature is not yet working correctly, so drivers have had to rely on radio and cellular telephone communications. This case study pointed to the importance of having a "store-and-forward" feature with an MDT system so that text messages that are not transmitted immediately are eventually either delivered to the intended recipient or back to the sender. Without this feature, the text messaging function can unreliable and may not be used by the drivers.

8.2 Institutional and Organizational Issues

All ITS projects inherently have a number of institutional and organizational issues that are uncovered during the project deployment. The following paragraphs highlight some of the issues that occurred at the case study sites during their implementations. By understanding the types of issues that might arise, other agencies can be prepared to deal with them at the outset of their ITS projects.

- ***Make sure all of the stakeholders are involved in the project, especially in the initial planning and design stage.*** It is important to include all of the stakeholders in the planning process to ensure that their needs will be met by the new technology. This may include maintenance, drivers, customer service, and operations planning functions. Involving these departments early on will also secure their cooperation later on in the deployment process. Additionally, it is important to involve other agencies that have a stake in the project (such as MPOs and regional FTA staff) in order to make sure their needs are being met as well. For example, CARTS ensures that the LCRA is involved in any ITS project planning process since the outcome of such projects could affect or be affected by the LCRA's radio system.
- ***For projects that involve multiple agencies, developing Memoranda of Understanding (MOUs) can help clarify each participant's responsibilities.*** For example, in Florida each CTC has been required to sign an MOU with the CTD outlining each party's responsibilities. These documents have been important in helping the CTCs understand early on what would be involved in participating in the project.
- ***Anticipate organizational changes.*** Try to anticipate the organizational changes that will be necessary once the technology is implemented so that organizational disruption is minimized when the deployment is complete. For example, the implementation of an automated fare collection and revenue control system may prompt the reorganization of the revenue department or the addition of staff. These organizational impacts should be considered during the design stage so that they can be handled appropriately well in advance of the implementation stage.
- ***ITS solutions have the potential to foster better cooperation and coordination between project participants.*** While the level of coordination originally envisioned never came to fruition in Florida, coordination between some of the counties did improve. Similarly, prior to implementation of the CRRAFT software in New Mexico, there was little coordination between the transportation operators and the case workers. The software has greatly improved both the cooperation between these groups, as well as the consistency of information available to them. However, it should be noted that making an effective connection between the case workers and transportation operators did require new statewide procedures, as may be the case in other states looking towards similar solutions to their coordination needs.
- ***Sometimes the project participants can change, so it is important to be flexible.*** While ideally, all of the participants involved at the outset of a project would remain with the project until the end, this is not always the case. For example, in Florida, the CTC designation changed in Alachua and Levy counties, causing the termination of the counties' participation in the project. However, the CTD was able to transfer the equipment from Alachua and Levy Counties to another rural county, and thus did not lose the resources they had invested in that CTC. The ability to

recover from unforeseen events is an important skill to foster with any ITS implementation, particularly those that involve a number of different participants.

- ***Identify how the project will benefit participants.*** It may be necessary to demonstrate to participants that the ITS application will benefit them directly. Although it may be difficult to quantify these benefits, providing at least a description of how participants can use the system to improve their operation can greatly increase their willingness to participate in the project.
- ***Be open to working with new agencies and staff.*** Rural transit systems are accustomed to communicating with State DOTs, which generally provide the bulk of their funding. However, with ITS demonstration projects, they may suddenly need to deal with other agencies, such as the FTA. Funding from different agencies may mean that the rural operator is faced with multiple reporting requirements, and they need to be prepared for this change. The case studies show that there has been good support from State DOTs and the USDOT's ITS peer-to-peer program for rural agencies deploying new technologies.
- ***Involving drivers in the installation and implementation of on-vehicle systems is critical to success.*** It is important for drivers to "buy into" the system since they are a key component of agencies' operations and they have to live with the technology as much as or more than any other transit staff member. However, drivers often experience "big brother" fears, particularly with the installation of AVL systems that track their locations. The case studies exhibited some interesting ways in which agencies can solicit the involvement and cooperation of drivers. At OTA, reports generated with AVL system data have been used to resolve customer complaints in drivers' favor, which has helped with driver acceptance of the system. At River Valley Transit, the vendor set up a sample MDT in the driver's room a few weeks prior to installation so that drivers could be come familiar and comfortable with it.

8.3 ITS Applications and Technology

The following paragraphs summarize the ITS Applications and Technology considerations that emerged from the Rural ITS case studies.

- ***Commercial off-the-shelf (COTS) software is not always the best solution.*** Sometimes it is easier to build a system from the ground up if a COTS package does not address the agency's requirements. If an agency does decide to build a system in-house, they should consider formulating an in-house development team similar to a commercial operation - a strategy that has worked well for ATRI. Additionally, agencies that decide to develop a system in-house should think carefully about the intellectual property rights that may be involved and potential future licensing issues.
- ***Do not underestimate the power of GIS.*** While a GIS is an assumed component in many (especially urban) ITS deployments, it can be a significant standalone ITS deployment for rural transit agencies. Results of GIS applications have given the smaller operators new tools for improving service planning and operations. Also, GIS may provide the basis for additional transit ITS deployments such as AVL/CAD and scheduling systems.

- ***Technology changes fast, so make sure your system can be easily upgraded.*** In today's changing environment, it is important to ensure that your ITS system can be easily expanded as technology evolves. For example, an agency may want to make sure that their system has "flash" capability or can accept software upgrades via remote access software. These tools may greatly improve the ease with which system upgrades can be made.
- ***Reserve adequate time for data preparation.*** The case studies showed that agencies' existing databases needed a significant amount of "scrubbing" before they were compatible with new software. In some cases, data interfaces needed to be created between legacy systems and new technology. Agencies often underestimate the amount of time it will take to prepare their data for entry into a new system.
- ***Perform a comprehensive communications/radio analysis.*** The case studies indicated that rural agencies are continuously having problems with new radio systems. For example, OTA's radio system was not configured to have the necessary capacity to handle both voice and data transmissions simultaneously, which became a problem when they tried to use the text messaging functions on their MDTs. Therefore, agencies should do a comprehensive communications analysis prior to implementing an ITS application that will depend heavily on a communications backbone.
- ***Web-based solutions may be appropriate for rural areas that are spread over a large geographic area.*** For example, ATRI is planning on installing their system throughout the state of New Mexico, which covers a very large geographic area. They decided it would be most effective to develop a Web-based solution, which allows them to provide support from a remote location. Of course, this type of solution can also present a challenge if the remote rural areas do not have adequate Internet access. Therefore, the agency deploying the technology should evaluate the ability of participants to access the Internet before developing a Web-based solution, particularly if a significant amount of data will be transferred on a regular basis.

8.4 Funding and Other Financial Considerations

- The case studies highlighted a number of funding and other financial considerations that are important to rural transit agencies undertaking ITS projects. The following paragraphs describe some of the key financial considerations from the case studies.
- ***ITS projects include many (sometimes unanticipated) costs.*** It is important for agencies to realize ahead of time that costs will arise throughout the project deployment, as well as during everyday operations. Typically, ITS deployments include initial start-up costs, capital costs, on-going maintenance and upgrade costs, and costs associated with staff time and effort.

Table 2 Summary of Funding Sources Used by Case Study Participants

	CARTS	Florida	New Mexico	Ottumwa (IA)	River Valley Transit (PA)
FEDERAL	V	V	V	V	V

FUNDING					
State Funding	V	V	V	V	V
Local Funding		V		V	V
Private / Institutional Funding			V		

- ***A number of different funding sources may be available for ITS projects.*** For example, the case study sites in this project typically used a combination of federal, state, and local funding. The funding sources uses are summarized in Table 2.
- ***Always be searching for potential funding opportunities.*** When deploying ITS solutions, agencies should keep abreast of potential funding opportunities in case existing sources are not adequate or become temporarily unavailable. In this way, agencies can avoid having to postpone or dramatically delay their implementation progress if funding constraints emerge.
- ***Creativity and innovation can pay off in terms of funding.*** Agencies can also benefit from being creative and innovative in obtaining funding for their ITS deployments. For example, multiple funding sources may be combined for a project or new funding sources might be explored.
- ***Do not expend all funds in a project – hold some funds for unexpected circumstances.*** As mentioned previously, rural agencies should "expect the unexpected" when deploying new technologies. Agencies need to be flexible, realizing that everything will not run smoothly. Agencies need to have the ability to add enhancements or fix problems when they arise. Keeping contingency funds for such occurrences can allow the agency to cope with these situations.

8.5 Rural Transit ITS Project Benefits

The case studies highlighted a number of benefits that may result from ITS deployments at rural transit agencies. The following sections list benefits that agencies might expect to experience in deploying these types of technologies. First, general project benefits that are not related to a specific technology are presented. Following this are benefits experienced by agencies implementing specific technologies, namely mobility management software, AVL/MDT systems, and customer information systems. Of course, the benefits that may actually be realized by rural systems deploying ITS technologies reach much farther than those enumerated below. However, our hope is that highlighting some of the experiences of agencies that have already implemented these technologies will provide an understanding of the potential of technology in rural transit systems.

8.5.1 General Project Benefits

- ***Increased agency collaboration*** - ITS projects can foster the development of better working relationships and partnerships between agencies. For example, CARTS developed an excellent relationship with LCRA, and the CTCs in Florida are now better coordinating their services and taking part in peer-to-peer training.
- ***Increased ridership and revenue*** - ITS increases the attractiveness of the transit service to "choice" riders, which could potentially increase ridership and farebox revenues.
- ***Increased community confidence*** - ITS deployments have the potential to increase community confidence in the agency's ability to operate an efficient, effective transportation system. For example, in St. Johns County, Florida, increased community confidence has allowed the operator to successfully lobby for a grant to implement a more traditional fixed route service.
- ***Increased self-confidence of agency staff*** - Through education and exposure to technology, agency staff self-confidence may increase.

8.5.2 Reservations/Scheduling/Dispatch Software

- ***Customer service*** – These types of software allow agencies to provide all passengers with the same level of service by using a uniform approach to reservations and scheduling. In some cases, they also improve customer service by improving the agency's ability to book trips in real-time, rather than having to call clients back to schedule a trip. Additionally, since trips can be more efficiently scheduled, on-time performance may potentially increase.
- ***Improved scheduling procedures*** – This type of software has allowed agencies to improve their scheduling procedures and increase productivity. For example, agencies have been able to provide more pick-ups and have developed "fixed routes" from subscription trips.
- ***Increased productivity*** - The software systems have helped agencies schedule a greater number of trips per hour, which, in turn, helps improve accessibility for clients since more service is provided at the same cost.
- ***Better connections for customers*** - Scheduling software can help agencies provide better connections for customers traveling between various service areas, particularly if it increases coordination between different providers.
- ***More efficient billing procedures*** - The software can result in more accurate and timely billing, and in a reduction in time spent on these functions.
- ***Potential staff reduction or re-assignment*** - In St. Johns County, Florida, the new software has allowed the agency to reduce their intake, billing, and scheduling staff, resulting in a more efficient operation.
- ***Efficiency*** - These systems can help providers better allocate their resources by improving the information available to them. For example, ATRI's CRRAFT system will make information about vehicle usage more accessible to providers, allowing them to more easily engage in "load balancing".

- ***Uniformity of information*** - For multi-agency implementations, these systems can increase the consistency of information, particularly information used for reporting and billing purposes.

8.5.3 AVL/MDT Systems

- ***Better customer service*** - Since dispatchers can see the location of buses, they have the ability to more easily make "on the fly" schedule changes and to better answer "where's my bus" inquiries.
- ***Increased system safety*** - The increased level of communication provided by AVL/MDT systems can increase the safety of the system. Since dispatchers can track each vehicle's location, incidents can be quickly recognized and the appropriate resources dispatched.
- ***Less noise on buses*** - By decreasing the amount of voice radio chatter, MDTs that use data messaging can greatly reduce the amount of noise on buses. Additionally, text messaging allows confidential information to be relayed between drivers and dispatchers without broadcasting it throughout the entire radio system.
- ***Reduced data entry time*** - MDTs can reduce staff data entry time, particularly with features such as electronic pre-trip vehicle inspection reports.
- ***More informed maintenance decisions*** - Pre-inspection reports, such as those used by OTA, can help inform maintenance personnel about potential problems. This functionality is especially useful in geographically spread-out systems, where vehicles may not all be housed and/or maintained in a central location.
- ***Better control over driver pay hours*** - MDT systems that require drivers to log on and log off can help management maintain better control over driver pay hours.
- ***Better schedule adherence tracking*** - AVL systems can help management track schedule adherence, which helps them track driver performance and better manage operations.

8.5.4 Customer Information Systems

- ***Better customer service*** - Information systems allow agencies to give their customers better information, which can improve their impression of the system and possibly even increase ridership. For example, River Valley Transit's in-terminal information system helps riders find the appropriate vehicle, in an environment where it would otherwise be difficult to do so.
- ***Fewer inquiries to agency staff*** - The systems can also result in fewer inquiries to transit agency staff since customers are being provided with better and timelier information.
- ***Increased accessibility for persons with disabilities*** - If the customer information system includes visual and audio announcements, it can be especially helpful for people with disabilities. River Valley Transit's customer information system, for example, provides both visual and audible announcements that direct riders to the appropriate bus bay. Without this technology, it would be difficult for a person with a visual or hearing impairment to find their way through the transit center to the appropriate bus bay.

8.6 Deployment Process Considerations

8.6.1 Project Planning

The following paragraphs summarize the project planning considerations.

- ***Have a project plan.*** It is important to have a well-specified plan before embarking on any ITS project. Furthermore, it is helpful to develop a set of objectives beforehand, so that the project's success can be measured after implementation.
- ***Consider the use of outside expertise.*** The use of outside professional expertise for activities such as writing systems specifications or providing systems integration support may be helpful for rural transit agencies planning ITS procurements. However, it is important for agencies to provide consultants with a clear scope of work that is consistent with their contractual arrangements with vendors and their expectations. This scope should include roles and responsibilities for both the consultant and key agency staff. Additionally, agencies using outside consultants need to make sure that key agency staff continue to be involved in the deployment.
- ***If your agency lacks technological expertise, think about using proven technologies.*** Agencies that are not technologically sophisticated may want to concentrate their planning and procurement efforts on proven technology. For example, CARTS felt that they needed a proven, successfully implemented technology and did not want to be a test site for new software. Therefore, they found an off-the-shelf product that met their needs and helped them "keep it simple."
- ***Recognize that ITS planning and design is not a simple task.*** There are many more technology and vendor options available to agencies today than there were a few years ago. Agencies need to recognize that the ITS planning and design function is not as simple as selecting among a relatively small number of vendors. There are many more activities involved in system planning and design. The FTA Policy on ITS Architecture Consistency includes several system planning and design steps that can assist agencies with these processes.[37]
- ***Make sure that the proposed technology is appropriate.*** Make sure that your deployment has been based on a systematic planning process at the local or state level, and that the technology is meeting a specific agency need. A systematic planning process for ITS projects should include the following steps:

  - → Issue/Problem Recognition;
  - → Project Definition;
  - → Needs Analysis;
  - → Planning and Design;
  - → Development/Procurement (includes Specifications Development);
  - → Training;

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[37] See more information at the following Web site: http://www.its.dot.gov/aconform/aconform.htm.

- → Installation and Testing;
- → Implementation/Operation;
- → Systems Maintenance/Upgrading; and
- → Evaluation.

- ***Conduct formal technical and organizational needs assessment prior to beginning your ITS deployment.*** The needs assessment helps to determine exactly what technology is needed and can help identify the technical and organizational barriers that might hinder the successful deployment of the ITS technology. Additionally, the needs assessment can simply help the agency learn more about their own operations. For example, the baseline studies in Florida proved valuable even without the technology project by helping the participants identify better methods of operation and planning.
- ***Be clear on your project goals and objectives.*** The agency should plan on evaluating how well the technology is meeting the project's goals once the system has been implemented. The evaluation process is important to help measure the success of the project, and may also help recognize benefits that were not expected. This, in turn, may ultimately serve to give agency staff a better sense of accomplishment and purpose and may help them better structure the project.
- ***Identify the operations data that you want to collect with the ITS system.*** ITS systems can generate a huge amount of data, and it can be difficult to manage and use it. In other words, agencies may experience "information overload." Therefore, system managers should determine what data is necessary and plan on how to use this data before reports are generated. The agency should determine the performance measures needed to evaluate their services, and those data elements that will be necessary in calculating these measures.
- ***The integration of your various ITS elements is critical to getting the most out of the technologies.*** It is important to address ITS integration issues early on in the planning stage, especially if the deployment is designed to take place incrementally. For example, CARTS thought early in the planning process about how the various components of its deployment would be integrated, and this helped avoid potential integration problems later on.
- ***Address system expandability early in the process.*** It is important to keep expandability of the system in mind, as the needs of end-users will likely change over time. ITS systems should have the capability to handle changing needs. For example, ATRI's system does not currently have a GIS capability, but in anticipation of future needs, the system has been designed in a way that this functionality can be added later on with minimal effort.

8.6.2 Procurement

The following paragraphs summarize the procurement considerations.

- ***Understand what vendors have to offer and maintain reasonable expectations.*** Rural systems depend heavily on vendors for specific information on transit ITS applications. In many cases, transit ITS solutions have been oversold or agency expectations have been unreasonably high. This can lead to agency ITS needs not being met by product vendors.

- ***If the deployment involves various operators/agencies, think about their individual needs.*** This may be particularly important when using a commercial off-the-shelf product for a number of different operators (as in a statewide implementation). For example, the CTCs in Florida had different needs and planned to use the software to different degrees. Some CTCs had high percentages of standing order trips, while others did not. Therefore, the CTD had to ensure that the software it selected met all of the participants' needs.
- ***The procurement process sets the tone for the whole project.*** Agencies need to realize that a sound contract does not necessarily mean that the project will be smooth and without conflict. They must establish a good working relationship with their vendors. Management needs to understand enough about the technology to ask the right questions. Outside assistance (see above) can be helpful in this regard, but agencies should then consider retaining the assistance through the entire planning, procurement, installation, and testing process.
- ***Consider performance-based contracts, including incentives and penalties.*** One way of avoiding problems later in the ITS deployment is to write performance-based contracts with vendors. For example, agencies can develop project milestones, with payment to vendors dependent on reaching these milestones. In this way, vendors have an incentive to do a good job and meet the project schedule.
- ***Make sure you can engage in the "technology talk."*** If the agency is using an outside vendor, they risk giving up control to the “techies” unless someone at the agency can speak their language. Agencies should think about having a staff member who can deal with the technical issues, so as not to rely solely on the vendors for technical support.
- ***Writing technical specifications may not provide the results desired.*** In general, the case study participants found that using either functional specifications or a hybrid of functional and technical specifications was the best way to obtain the appropriate system within their budget. Functional specifications can give the vendor the concept of what the agency wants, while at the same time challenging the vendor to design a workable solution that may differ slightly from the agency’s requirements. This approach worked well for River Valley Transit. By not being given narrowly defined system specifications in the RFP, the vendor was encouraged to be creative. River Valley Transit staff were able to enter into a creative design session with the vendor that resulted in an appropriate solution.
- ***Make sure documentation is included in vendor contracts.*** Documentation is important and agencies should insist on receiving adequate documentation from vendors. Documentation may include operational and maintenance manuals, system administration operations manuals, communications protocols manuals, training materials, or other such documents. One reason for this is that staff turnover is inevitable, and having proper system documentation will help new staff become more quickly acquainted with the technology.
- ***The vendor's experience with similar deployments is important.*** Make sure to check the vendor's track record and ensure that they have the necessary experience to deal with your system

and your issues. If a vendor does not understand your system, they may not be able to provide the support you need. Therefore, it is important to check vendors' references, particularly at agencies that have similar characteristics to your own. Agencies may want to visit sites where the vendor has installed similar systems.

8.6.3 Project Installation and Implementation

The following paragraphs summarize the project installation and implementation considerations.

- ***Do not rush the implementation.*** By trying to install and implement new technology too quickly, problems may be created that will be difficult to correct in the future. For example, Marion County, Florida had only a few months to get their system up and running, and felt that they would have benefited from a more incremental approach to start-up. Additionally, if implementation is too rushed, staff may not have time to become accustomed to the technology and, therefore, may not fully realize its potential benefits.
- ***Incremental start-up seems to have worked well for most agencies.*** CARTS, for example, implemented components of its ITS deployment one at a time, which helped them address problems more easily than if they had been trying to integrate multiple components all at once. However, one issue associated with this approach is the ability to obtain funding in a timely manner for a system that has, by design, been implemented incrementally.
- ***Implementation should include a pilot phase, in which hardware is installed on only a portion of the fleet and fully tested before full installation is completed.*** Piloting allows the agency to work out any "bugs" in the system prior to installing hardware on all vehicles. This is particularly important since, once full installation occurs, all vehicles must be brought into the maintenance facility in order to repair problems with the in-vehicle equipment (although regular mechanical repairs may be done at the local sites). CARTS and River Valley Transit both had pilot phases, and both felt that this greatly helped their implementation to be accomplished more smoothly.
- ***Be flexible and patient.*** Seldom does everything go as smoothly as planned with ITS deployments (or other complex IT systems), so agencies need to be flexible and patient, particularly when problems arise. Having a willingness to stray slightly from the planned deployment schedule can sometimes help the implementation move ahead more quickly and efficiently. For example, ATRI had initially envisioned that each transportation center would do their own data entry into the CRRAFT system. However, they quickly discovered that transportation staff did not have the necessary time to perform this function. Consequently, ATRI staff decided to do the initial data entry. ATRI's flexibility, in this case, helped the project get up and running more quickly that it otherwise would have.
- ***Having clear sign-off and acceptance procedures for new technology is essential.*** Contracts with vendors should include an acceptance-testing phase as part of the implementation process for new technology. In this way, the agency is not left with a system that does not function properly once the vendor has left the picture. For example, in Williamsport, the vendor provided an end-to-end solution, which included clear testing and acceptance procedures. This arrangement has

resulted in a positive relationship between the agency and the vendor and has been key to the project's successful implementation.

- ***Establish a formal process to track problems during implementation and operations.*** A good example of such a process is the Problem Identification Report used by River Valley Transit. The 4-page form can be filed by any employee using the system and is used to quickly identify problems so that they can be resolved in a timely manner.

8.6.4 Operations

The following paragraphs summarize the operational considerations.

- ***Technical support is very important in any ITS deployment.*** It is important to maintain support agreements with the vendors and/or develop the necessary in-house expertise to deal with technical issues. A good example of this practice is CARTS, which has an agreement with their vendor, but also has a part-time staff person devoted to technology support as his primary responsibility. Once the remaining MDTs are installed, this person will start providing technical support on a full-time basis. CARTS feels that this approach works better than relying solely on the software or hardware vendor because it enables problems to be resolved more quickly.
- ***ITS deployments that include a GIS component may require on-going staff support for data maintenance functions.*** Agencies' service areas are continuously changing, requiring on-going changes to underlying GIS data. While agencies may be able to rely on vendors for some changes, they may have a need for in-house support to deal with on-going, minor changes.
- ***Training staff in the use of transit ITS is as important in small rural transit agencies as it is in much larger deployments.*** Some rural ITS deployments have focused heavily on training. At CARTS, for example, each RFP has stressed the importance of training, and the RFPs called for initial training, advanced training, and annual user group meetings. On the other hand, many agencies have fallen short in this area. Agencies should realize that vendor training is not the only option available. As seen in the Florida demonstration project, peer-to-peer training can be a very useful and cost-efficient training method. However, when using this method, agencies need to keep in mind that different operators have different needs, so they must think carefully about the transferability of knowledge. Additionally, should consider using Web-based training as it becomes available. This type of training may not take the place of individual or on-site training, but can be a useful supplemental tool and is a cost-effective way to provide on-going training as the system evolves.
- ***Install software on managers' computers.*** Agencies sometimes have a tendency to only install software for the people who will be using it on an everyday basis. However, by giving managers access to the technology, this enables them to better understand problems that their staff may be having with the system. In Ottumwa, for example, the Transit Administrator eventually had the AVL/MDT software installed on her computer. She believes this has been beneficial since she now understands the problems that the dispatchers are having with the system.

- ***Think about strategies to save bandwidth, particularly if you have communications constraints.*** Since many rural agencies have issues with their communications capacity, it is advisable to look for methods to economize in this area. For example, CARTS allows their dispatchers to initiate polls on the AVL system in order to cut down on the polling cycle, which saves bandwidth.
- ***Conduct outreach to ensure that project accomplishments and successes are well publicized.*** Successes may come in many forms and may be different from your original goals, but are successes nonetheless. Agencies should consider making presentations at conferences, being a "peer" to help other agencies implementing ITS technologies, or other means of distributing information about their successes.

Appendix A. Literature Reviewed

During the literature review phase of the Rural ITS project, the project team reviewed a number of documents that were related to Rural ITS operational issues. This bibliography includes a list of the key sources reviewed.

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Appendix C. Case Study Interview Outline

DISCUSSION AREA	**SAMPLE TOPICS, ISSUES, AND QUESTIONS**
SYSTEM/PROJECT OVERVIEW	
Central Focus of Case Study	
System/Project Name	
Project Status	Is the project fully operational, partially operational, in start-up mode, or another phase, etc.?
Brief Project History/Relevant Dates	Approximately when did project planning start? How long did it take to procure the system? How long did it take from finalizing procurement to start-up? Approximately when did the project become partially and/or fully operational? How long has the project been partially and/or fully operational?

DISCUSSION AREA	SAMPLE TOPICS, ISSUES, AND QUESTIONS
Overall ITS System / Major Technologies Used	Can you give us a general overview of your ITS project as it exists today? What are the major ITS technologies used in the system?
Transit Service Affected	
Current Usage / Numbers	How many staff are affected by the system? How many vehicles have been equipped? What percentage of your customers is affected, directly or indirectly? Are there any other organizations involved in the project's operation?
Regional / State ITS Architecture	Is the project part of or included in any ITS Architecture process or documentation?

DISCUSSION AREA	SAMPLE TOPICS, ISSUES, AND QUESTIONS
Overview of Goals and Objectives	Although we will discuss this in depth later, can you give us an overview of the project's <u>current</u> goals and objectives? "Be able to communicate with all vehicles" "Locate vehicles in the service area" "Know what vehicles are doing" "Apply technology to facilitate the agency's billing process?"
Needs Assessment	Was any sort of a needs assessment conducted?
STAKEHOLDERS	
Stakeholder Identification	Which Stakeholders are still active in this project, especially those upon whom the system operation has a direct or indirect impact? Who dropped out and why? What are the Stakeholders specific responsibilities now?

DISCUSSION AREA	SAMPLE TOPICS, ISSUES, AND QUESTIONS
Stakeholder Participation	What is the role of the Stakeholders now? How has that changed? What is the primary interest of these stakeholders during the operational phase of the project? In what ways are the stakeholders participating?
Outreach/ Feedback	How do keep Stakeholders interested and involved? How do you obtain feedback from them about the success/failures of the system?
Issues with Stakeholders	How are you dealing with different needs of Stakeholders, especially where it involves tradeoffs?
GOALS AND OBJECTIVES	
Identify Goals and Objectives	What were the original project goals and objectives, hopes, etc?

DISCUSSION AREA	**SAMPLE TOPICS, ISSUES, AND QUESTIONS**
Realization of Original Objectives	What impacts or outcomes were anticipated for the project? Of the anticipated impacts, which have been realized? Of the anticipated impacts, which have been not been achieved? Why not? Of the anticipated impacts, which have been modified or dropped?
Challenges	Did the implementation of ITS involve more or less staff time (e.g., PM, PM2, Tech Staff, Ops Mgr., etc) than anticipated? Why? Were there other challenges?
New Objectives, Uses, or Applications	As the project has progressed toward operations, have new objectives, uses, or applications of the ITS system come to light? Have any of these been implemented or are in the planning stages?
Evaluation	Has your agency or funders done any internal evaluations of the project?

DISCUSSION AREA	SAMPLE TOPICS, ISSUES, AND QUESTIONS
DESCRIPTION OF SYSTEM AND TECHNOLOGY	
System Overview	Can you describe the basic project system architecture, its key processes, and information flows? Who did the primary design work? Were there other ITS or related projects that were used as examples in developing the system?
Procurement	Was the system purchased through a Bid or an RFP?
Functionality	What are the primary functions of the system? What are the secondary functions of the system? How did you pick the functions you needed? Was any informal needs assessment conducted?

DISCUSSION AREA	SAMPLE TOPICS, ISSUES, AND QUESTIONS
	What standards were followed in designing the system?
System Changes	What are the major ways the system has changed since its conception? How has it changed since procurement and deployment? Since it became fully operational?
System / Technology Selection	How were any particular applications, technologies, or systems chosen?
SUMMARY OF COSTS	
Technology Description	Can you describe any of the major technologies used in the system?

DISCUSSION AREA	SAMPLE TOPICS, ISSUES, AND QUESTIONS
Capital	How much did the system cost? How much was the system expected to cost? What was the cause of additional costs? How were they paid for? Probe for some additional high-level detail.
Start-up	What start-up costs were needed? Were these expected?
Other "Costs"	Were there any other indirect or intangible costs that we haven’t discussed?

DISCUSSION AREA	SAMPLE TOPICS, ISSUES, AND QUESTIONS
OPERATIONS AND PERFORMANCE	
Overview of Operations	What "departments" or staff positions are actively involved in operating the ITS system? What role is each playing? What agencies or private firms are involved in operations, maintenance, enhancement of the system?
Training	What type of new training did the ITS application require? How much training was necessary? Was training sufficient? Was the training investment worth it? How did you provide the training? What was the cost to the system in dollars/time? Did staff actively participate in the training effort? Have the results of the training effort affected the operation of the system?

DISCUSSION AREA	**SAMPLE TOPICS, ISSUES, AND QUESTIONS**
Resulting Changes	Which "departments" or staff positions have been most affected by implementing the ITS system? In what ways have they been affected or their day-to-day roles changed? Were any staff positions added or reallocated as a result of the system?
Positive Impacts	Does operation of the ITS systems involve more or less of your time, staff time, driver time, etc. than you anticipated? What are the best features of the ITS system?
Negative Impacts	Has the system required additional operational funding, either expected or not? What has been the source of that funding? What are the worst features of the ITS system?
Problem Solving / Work Arounds	What problems have arisen during operation and how did you overcome them? What have you done to track operational problems so that patterns could be identified and problems fixed?

DISCUSSION AREA	SAMPLE TOPICS, ISSUES, AND QUESTIONS
On-going Problems	What problems have not been solved? What are the plans for solving them? Who is responsible for, or involved in, solving the problems? Does this require an additional operating or capital cost?
Safety	Were there any safety issues that arose from the ITS implementation? How were they addressed?
Data	What sort of databases do you maintain? What impacts have your ITS applications had on the number, type, and content of your databases? How is the captured data used? What measures have you used to determine success?
Support	Who do you rely on for help when operational problems occur?

DISCUSSION AREA	SAMPLE TOPICS, ISSUES, AND QUESTIONS
LESSONS LEARNED	
Planning	What kind of planning took place?
Deployment	Did the deployment of ITS involve more or less of your time, staff time, driver time than you anticipated?
Start-Up	Did the start-up phase of ITS involve more or less of your time, staff time, driver time than you anticipated? What were the greatest challenges in implementation? What effect did they have on subsequent operations?
Operations	Does the operation and maintenance of ITS involve more or less of your time, staff time, driver time than you anticipated?
Feedback	What do your customers think of the ITS application? How have you addressed their emerging needs/desires?

DISCUSSION AREA	**SAMPLE TOPICS, ISSUES, AND QUESTIONS**
Organizational Levels	Lessons learned from the perspective of different staff positions.
Systems Integration	What challenges did you face integrating the system with legacy systems? What challenges did you face integrating the various components of your ITS system?
Specific	What are the three or four elements that have made the system a success at the project level, institutional level, technology, functionality levels? What were the critical design changes or work arounds?
General	What advice would you give to anyone considering it or trying to implement ITS? What are the three or four elements that have made the system a success? If you had to do it again what would you do differently?

DISCUSSION AREA	**SAMPLE TOPICS, ISSUES, AND QUESTIONS**
FUTURE PLANS	
Future Enhancements	What have you learned about expanding the system to add new functions, capacity, etc.?
From Current Project	How do you plan on building on the existing project? What are your near-term plans for modifying and expanding the system?
Opportunities	What opportunities are you trying to capture by expanding?
Challenges	What challenges do you face in expanding the system? How are you going to deal with those challenges?

DISCUSSION AREA	SAMPLE TOPICS, ISSUES, AND QUESTIONS
New Objectives, Uses, or Applications	

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EDL Document No.: 13784
Publication No.: FHWA-OP-03-077