Strategies to Expand and Improve Deployment of ITS in Rural Transit Systems

DETAILS

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TRANSIT COOPERATIVE RESEARCH PROGRAM

TCRP REPORT 84

e-Transit: Electronic Business Strategies for Public Transportation

Volume 6

Strategies to Expand and Improve Deployment of ITS in Rural Transit Systems

ACUMEN BUILDING ENTERPRISE, INC.
Oakland, CA

SUBJECT AREAS
Public Transit

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TRANSPORTATION RESEARCH BOARD

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TRANSIT COOPERATIVE RESEARCH PROGRAM

The nation's growth and the need to meet mobility, environmental, and energy objectives place demands on public transit systems. Current systems, some of which are old and in need of upgrading, must expand service area, increase service frequency, and improve efficiency to serve these demands. Research is necessary to solve operating problems, to adapt appropriate new technologies from other industries, and to introduce innovations into the transit industry. The Transit Cooperative Research Program (TCRP) serves as one of the principal means by which the transit industry can develop innovative near-term solutions to meet demands placed on it.

The need for TCRP was originally identified in *TRB Special Report 213—Research for Public Transit: New Directions,* published in 1987 and based on a study sponsored by the Urban Mass Transportation Administration—now the Federal Transit Administration (FTA). A report by the American Public Transportation Association (APTA), *Transportation 2000*, also recognized the need for local, problem-solving research. TCRP, modeled after the longstanding and successful National Cooperative Highway Research Program, undertakes research and other technical activities in response to the needs of transit service providers. The scope of TCRP includes a variety of transit research fields including planning, service configuration, equipment, facilities, operations, human resources, maintenance, policy, and administrative practices.

TCRP was established under FTA sponsorship in July 1992. Proposed by the U.S. Department of Transportation, TCRP was authorized as part of the Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA). On May 13, 1992, a memorandum agreement outlining TCRP operating procedures was executed by the three cooperating organizations: FTA, The National Academies, acting through the Transportation Research Board (TRB); and the Transit Development Corporation, Inc. (TDC), a nonprofit educational and research organization established by APTA. TDC is responsible for forming the independent governing board, designated as the TCRP Oversight and Project Selection (TOPS) Committee.

Research problem statements for TCRP are solicited periodically but may be submitted to TRB by anyone at any time. It is the responsibility of the TOPS Committee to formulate the research program by identifying the highest priority projects. As part of the evaluation, the TOPS Committee defines funding levels and expected products.

Once selected, each project is assigned to an expert panel, appointed by the Transportation Research Board. The panels prepare project statements (requests for proposals), select contractors, and provide technical guidance and counsel throughout the life of the project. The process for developing research problem statements and selecting research agencies has been used by TRB in managing cooperative research programs since 1962. As in other TRB activities, TCRP project panels serve voluntarily without compensation.

Because research cannot have the desired impact if products fail to reach the intended audience, special emphasis is placed on disseminating TCRP results to the intended end users of the research: transit agencies, service providers, and suppliers. TRB provides a series of research reports, syntheses of transit practice, and other supporting material developed by TCRP research. APTA will arrange for workshops, training aids, field visits, and other activities to ensure that results are implemented by urban and rural transit industry practitioners.

The TCRP provides a forum where transit agencies can cooperatively address common operational problems. The TCRP results support and complement other ongoing transit research and training programs.

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The members of the technical advisory panel selected to monitor this project and to review this report were chosen for recognized scholarly competence and with due consideration for the balance of disciplines appropriate to the project. The opinions and conclusions expressed or implied are those of the research agency that performed the research, and while they have been accepted as appropriate by the technical panel, they are not necessarily those of the Transportation Research Board, the National Research Council, the Transit Development Corporation, or the Federal Transit Administration of the U.S. Department of Transportation.

Each report is reviewed and accepted for publication by the technical panel according to procedures established and monitored by the Transportation Research Board Executive Committee and the Governing Board of the National Research Council.

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FOREWORD

By Gwen Chisholm-Smith
Staff Officer
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TCRP Report 84: e-Transit: Electronic Business Strategies for Public Transportation documents principles, techniques, and strategies that are used in electronic business for public transportation. *TCRP Report 84* will be published as multiple volumes; *Volume 6*: *Strategies to Expand and Improve Deployment of ITS in Rural Transit Systems* describes Internet and communication technologies that are being deployed at rural transit agencies. The report provides information on statewide intelligent transportation systems (ITS) plans that include provisions for rural ITS initiatives. This report may be used by transit managers and ITS specialists at small transit agencies.

The Internet and other new information and communication technologies are revolutionizing the way services are delivered and organizations are structured. Electronic business processes change the ways organizations operate and conduct business. Opportunities to lower transaction costs and improve efficiency have changed relationships between transit agencies and their suppliers and customers, and electronic business processes are likely to change industry structures in the long term. Portals for transactions in government-to-government and business-to-government marketplaces are offered through diverse organizations. Numerous transit agencies are preparing to offer customized itinerary planning and fare media purchasing over the Internet.

The declining costs of communications, data storage, and data retrieval are accelerating the opportunities spawned by the Internet and other information and communications technologies. Choosing and sequencing investments in technologies, processes, and people to reduce costs and increase productivity present challenges to the transit manager, who must weigh the costs, benefits, and risks of changing the ways services are delivered. To assist in meeting such challenges, TCRP Project J-09 produces a multiple-volume series under *TCRP Report 84.* The research program identifies, develops, and provides flexible, ongoing, quick-response research designed to bring electronic business strategies to public transportation and mobility management.

Strategies to Expand and Improve Deployment of ITS in Rural Transit Systems is the sixth volume in the *TCRP Report 84* multiple-volume series. Acumen Building Enterprise, Inc., of Oakland, California, prepared this report. This report describes the current state of technology and the various stages of ITS infrastructures at five rural agencies. The report also includes an overview of factors to consider when planning an ITS implementation.

Volumes issued under *TCRP Report 84* may be found on the TRB website at http://www4.trb.org/trb/onlinepubs.nsf/web/crp. (Click on “Transit Cooperative Research Program” under the “Project Reports” heading.)

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e-Transit: Electronic Business Strategies for Public Transportation: Volume 6

STRATEGIES TO EXPAND AND IMPROVE DEPLOYMENT OF ITS IN RURAL TRANSIT SYSTEMS

SUMMARY

Small and rural transit agencies may benefit from intelligent transportation systems (ITS) technologies; however, they frequently lack the resources to assess their needs and research potential technological solutions. To identify and examine available and emerging ITS technologies, their benefits, and their deployment potential to rural transit systems, this report summarizes information on rural ITS implementations found through a literature review and presents new information gathered from interviews.

The literature review findings (Chapter 3) present an overview of materials reviewed from previous research studies on the subject matter. *TCRP Web Document 20: Advanced Public Transportation Systems for Rural Areas: Where Do We Start? How Far Should We Go?* was prepared in June 2001 by the Institute for Transportation Research and Education (North Carolina State University, Raleigh) in association with KFH Group and TransCore for TCRP Project B-17. This report examined rural transportation agencies and their implementations of ITS technology. From this examination was developed a taxonomy for other agencies in similar situations to use when determining what ITS components may be procured.

TCRP Report 76: Guidebook for Selecting Appropriate Technology for Small Urban and Rural Public Transportation Operators was also prepared by the Institution for Transportation Research and Education (North Carolina State University, Raleigh) in association with KFH Group and TransCore for TCRP Project B-17. This report compiles the taxonomy presented in *TCRP Web Document 20* into a series of easy-to-use tables. This collection of tables can be used by transit professionals to evaluate potential ITS technologies based on the agency's transit system characteristics and needs. While this collection of tables can be used by transit agencies of any size, it was specifically crafted for transit agencies in rural or small urban settings whose ITS challenges may not mirror those of larger agencies.

A Federal Highway Administration (FHWA) document, "Rural ITS User Needs," was prepared in June 1999 by Science Applications International Corporation (SAIC) in association with Castle Rock Consultants, Western Transportation Institute, and Multisystems, Inc. The purpose of the document was to develop a comprehensive list of rural ITS user needs. Researchers identified the user needs by reviewing existing literature and attending a workshop involving various individuals involved with rural ITS. The majority of this FHWA document consists of the findings from the workshop.

In addition to reports and documents on the subject of rural ITS, information on existing and planned implementations, as well as information on larger federal or state ITS architecture, was gathered from web resources. The four most valuable websites were

- The U.S. Department of Transportation's (U.S. DOT's) Intelligent Transportation Systems (www.its.dot.gov),
- The American Public Transportation Association (APTA) (www.apta.com),
- The Intelligent Transportation Society of America (ITS America) (www.itsa.org), and
- The Transportation Research Board of the National Academies (www.trb.org).

For this study, five rural agencies that have implemented or plan to implement ITS technologies were interviewed (Chapter 4). Information was gathered from the following agencies:

- The Kansas Department of Transportation (DOT),
- The Community Action Partnership of Mid-Nebraska,
- Iowa DOT,
- California DOT, and
- Oregon DOT.

Table 1 presents the information on technology and needs serviced gathered from the agencies above. It matches the agency's specific need to a specific ITS solution. Further analysis (Chapter 5) reviews each of the technologies and determines what benefit the product will give, what additional infrastructure is required, and what cost is involved.

TABLE 1 Agency needs and planned/implemented technology

Agency	Need	Planned/Implemented Technology
Kansas DOT	Increased traveler information	Portable and overhead message boards, 511 traveler information via web and telephone
	More efficient dispatching	Computer-aided dispatching (CAD), automatic vehicle location (AVL)
	Increased rider convenience	Portable and overhead message boards, 511 traveler information via web and telephone, CAD
Community Action Partnership of Mid-Nebraska	Increased traveler information	Website development with real-time information
	More efficient dispatching	CAD, AVL, mobile data terminals (MDTs)
	Vehicle monitoring	Geographic information systems (GIS)/global positioning systems (GPS), AVL, MDTs
Iowa DOT	More efficient dispatching	CAD, AVL, MDTs
	Vehicle monitoring	MDTs, AVL
	Better communication with drivers	MDTs, wireless data communications system
	Simpler billing processes	Automated billing software
California DOT	Increased traveler information	Solar-powered message boards, website development with real-time information
	More efficient dispatching	CAD, AVL, MDTs
	Vehicle monitoring	GPS, MDTs, AVL
	Better communication to drivers	MDTs, wireless data communications system
	Increased safety	Silent alarms on vehicles linked to central dispatch
	Easier fare collection	Electronic fare media
Oregon DOT	Increased traveler information	Website development with service information, GIS-based map information
	Easier fare collection	Electronic fare media

CHAPTER 1

INTRODUCTION

While technology continues to evolve, finding the correct situational usage of its applications for the transit industry continues to be a challenge. The integration of ITS into small rural transit agencies exemplifies the difficulties involved in blending innovation with the need to meet customer and operational demands. Larger transit agencies have been more successful using ITS because they have more accessible resources, in both staff and funding, to implement such systems driven by measurable and concisely defined needs.

The deployment of ITS solutions in small and non-urban transit agencies continues to be slow; few operators reap the benefits of what could be cost-saving, effort-reducing technological developments in the industry. The biggest problem that rural agencies have in implementing ITS is the initial cost of determining which solution best solves the agency's problem and the cost of that solution. Funds are very tight in the current economy for all types of governmental agencies. The cost of implementing some of the more extensive ITS solutions is prohibitively expensive.

Another problem that smaller agencies, particularly transit agencies, have is that vendors develop systems for larger, more profitable agencies in an effort to maximize profit with larger procurements. Larger procurements are often customized with a myriad of options best suited for that particular agency. Small and rural transit agencies find their needs less complex, and complicated systems will hinder rather than help these agencies. Finding an ITS application of proper scale has sometimes proven difficult because many vendors are reluctant to invest their resources to retool or redesign a system to accommodate a smaller agency's needs.

The purpose of this research is to examine rural transit agencies that have implemented or are in the process of implementing ITS applications. The hope is that other small and rural agencies may benefit from this research. The research tasks were to

- Review past studies on the subject matter,
- Examine current implementers of ITS technology,
- Review the technology and its benefits, and
- Analyze solutions to low implementation rates.

For the purpose of this report, "rural" areas are defined as settled territories or areas with a population of less than 50,000 and without a central city. The research also includes organizational information as presented by transit agencies or vendors. Historical project evolution is described so that other agencies in similar situations or looking to implement similar technology will understand what may be involved. System integration with existing or planned regional or statewide systems is discussed. In addition, a review of other available or emerging technologies is provided. Finally, potential strategies for ITS integration of rural transit agencies into statewide ITS architectures is discussed.

ITS encompasses many technologies. At its broadest, it includes any technology that provides transit information or management benefits. According to Chris Winters at the Community Transportation Association of America, the central goal of ITS is to provide systems with the information and operational ability necessary to move people more quickly and more cheaply. For this research, ITS includes all electronic, communications, and/or computer systems that increase operational and service efficiency as well as potentially decrease costs.

CHAPTER 2

RESEARCH APPROACH AND METHODOLOGY

The objective of this chapter is to frame the research approach and methodology for this project. Numerous studies have been completed in the past, and the purpose of TCRP Project J-09(10) was to build upon information that had already been collected. New information was gathered and evaluated to document needs being addressed by current implementations. Additional technologies were then reviewed for applicability to rural and non-urban ITS transit systems.

2.1 REVIEW LITERATURE

As the objective of the research was to review existing and current implementations of ITS technology, the approach was to first identify rural transit systems using ITS. Past reports were examined to form the foundation of this study. Specifically, *TCRP Web Document 20: Advanced Public Transportation Systems for Rural Areas: Where Do We Start? How Far Should We Go?* and accompanying *TCRP Report 76: Guidebook for Selecting Appropriate Technology Systems for Small Urban and Rural Public Transportation Operators*, both prepared by the Institute for Transportation Research and Education (North Carolina State University) in association with KFH Group and TransCore, formed the basis of this study by providing a sample of the types of implementations that have occurred in the past.

In addition to the two documents listed above, various Internet resources were reviewed for pertinent information on technologies, transit agencies, and ITS procurements and implementations. A bibliography of relevant references is included at the end of this report.

2.2 IDENTIFY CONTACTS AND COLLECT DATA

The second step in the identification process was to contact state DOT officials involved with rural transit development to gather information on existing or planned statewide ITS architecture and implementation programs. Contact information on local transit operators whose properties are most progressive in technology implementation was obtained, when possible, from state DOT officials. These operators were then contacted for screening of ITS developments and asked for more specific information, such as regional/state planning, technology information, implementation schedule, associated costs, and operational factors.

2.3 IDENTIFY MAJOR NEEDS

The information was collected, and the major needs addressed by the ITS implementations were evaluated on the basis of agency responses. These responses were classified using the definitions in *TCRP Report 76*. The classification evaluated which of the major needs were most prominently addressed and established a benchmark for other agencies that either want to address a particular need or may see multiple needs addressed by a single technology. Not all of the needs listed in *TCRP Report 76* were addressed by the agencies contacted.

2.4 REVIEW TECHNOLOGY

The project team examined technologies that may have potential usages in rural transit agencies. These technologies (1) were in use in larger transit operations and were scalable, (2) were not in use in transit but may have applicability, or (3) were still in the development stages. Each technology was examined for applicability in the rural setting. Examples include fare collection equipment, network, and communications software applications.

The research team examined reported organizational, management, and training systems for rapid deployment of ITS in rural transit with relation to implementation. Schedule adherence was also examined, as were any “lessons learned” provided by the participants. Suggestions for regional or statewide implementations from a technological standpoint were also included in the report as recommendations for interoperability.

CHAPTER 3

LITERATURE REVIEW FINDINGS

The objective of this chapter is to review the findings from previous research studies already conducted on the subject matter. The purpose of TCRP Project J-09(10) was not to duplicate work, but rather to build upon work already completed. As such, an overview of materials reviewed is presented below for ease of reference and understanding of the research approach.

3.1 TCRP WEB DOCUMENT 20

TCRP Web Document 20 examined rural transportation agencies and their implementations of ITS technology. From this examination was developed a taxonomy for other agencies in similar situations to use when determining what ITS components may be procured. Measures of effectiveness, cost systems, and integrated developments with other transit operators or state agencies were also presented.

The Project B-17 research team initially contacted 25 rural and small urban transit properties to obtain information about the ITS implementations performed on these sites. Based on the information collected, 13 sites were contacted again for additional information, and 6 of these 13 were ultimately selected for detailed examination and case studies. The 6 selected were

- Aiken County Council on Aging (Aiken, South Carolina),
- Arrowhead Transit (Virginia, Minnesota),
- Cape Cod Regional Transit Authority (Dennis, Massachusetts),
- Capital Area Rural Transit System (CARTS) (Austin, Texas),
- Community Transit of Delaware County (Eddystone, Pennsylvania), and
- Flagler Senior Services (Palm Coast, Florida).

From interviews and site visits, the research team found information on the stated reasons for implementing technology, the leadership and vision necessary to guide the implementation and adoption of ITS technology, information on partnerships, the need for formalized planning processes, organized implementation processes, the need for comprehensive system designs, ideas on procurement approaches, and the benefits associated with adopting various ITS technologies.

The information gathered from the various agencies was then used to develop the taxonomy for selecting ITS technology in rural settings. The research team determined that while there are numerous factors to consider when evaluating technology, for ease of use, the primary dimensions for the taxonomy would be system size and transit system needs. System size was categorized as

- Small rural transit system—operating fewer than 10 peak vehicles,
- Medium rural transit system—operating between 10 and 30 peak vehicles, and
- Large rural transit system—operating more than 30 peak vehicles.

The transit system needs identified by the report were as follows:

- More accurate, easier reporting and record keeping;
- More efficient service coordination;
- Safer, more accurate cash handling;
- Improved operations, performance, and productivity;
- More effective maintenance tracking;
- Clearer communications among customers, operations, and vehicles;
- More effective dispatching;
- Faster, more efficient trip request processing;
- Improved scheduling productivity;
- Improved service quality;
- Greater safety; and
- More accessibility and more useful customer information.

These two sets of dimensions—system size and system needs—were further refined into a guidebook presented as *TCRP Report 76*.

With any implementation used to address particular needs, measures of effectiveness must be included to gauge success. The research team provided a schema to measure potential benefits, costs, and data collection effectiveness. Most transit agencies and managers find this evaluation difficult and time consuming, and therefore they rely on broader, non-specific performance measures.

The funding of rural ITS technologies was the last area that was researched. Traditionally, monies come from federal and state capital programs as well as special ITS demonstration programs. However, as funds are becoming more limited, creative methods must be used to fund new procurements, such as joint procurements or partnerships with other agencies as well as tie-ins with capital or operational projects.

3.2 TCRP REPORT 76

TCRP Report 76 is a companion document to *TCRP Web Document 20*, taking the taxonomy presented there and compiling it into a collection of easy-to-use tables. This collection of tables can be used by transit professionals to evaluate potential ITS technologies based on the agency's transit system characteristics and needs. While this collection of tables could potentially be used by transit agencies of any size, it was specifically crafted for transit agencies that are in rural or small urban settings whose ITS challenges may not mirror those of larger agencies. The document is divided into six chapters:

- Conducting a Self-Assessment,
- Matching Needs and Technologies,
- Investigating Functionality and Costs,
- Financing Technology Systems,
- Implementing Technologies, and
- Summary.

This division presents a logical, step-by-step evaluation and planning methodology. It lists the 12 identified needs; organizational, planning, and implementation approaches; potential technologies (defined and categorized as basic or advanced); and funding considerations. While the information presented in this guidebook is comprehensive, the guidebook is intended to be used as a guide, not an all-inclusive document. As such, suggestions are given based on previous research on actual implementations.

3.3 FHWA'S "RURAL ITS USER NEEDS"

The FHWA document entitled "Rural ITS User Needs" developed a comprehensive list of rural ITS user needs. These needs were to be included in the National ITS Architecture and Standards in order to provide a level of standardization and uniformity when developing interoperable systems. The user needs identification was performed by reviewing existing literature and attending a workshop involving various individuals involved with rural ITS. The majority of this report consisted of the findings from the workshop.

The user needs for the workshop were grouped into the following seven categories:

- Emergency Services,
- Tourism and Travel,
- Traffic Management,
- Rural Transit and Mobility,
- Crash Prevention and Security,
- Operations and Maintenance, and
- Surface Transportation Weather.

There were overlaps in specific needs because these needs could address multiple areas.

3.3.1 Emergency Services

Emergency Services focuses on ways to improve emergency response processes. Because accidents in rural areas can go unreported or undetected for longer amounts of time due to infrequent travel in the area, better preventive and monitoring processes, along with improved communications systems, can help save lives. Specific Emergency Services needs can be broken down even further into categories:

- Response Information,
- En-Route Services Information,
- Emergency Assistance, and
- System Operational Effectiveness.

3.3.2 Tourism and Travel

Tourism and Travel needs focus on providing information and transit services to visitors. As stated in the FHWA document, "Providing services to tourists and others unfamiliar with the rural surroundings enhances the economic vitality of the area." As such, it is important to assist these individuals by providing access to the rural regions.

Specific Tourism and Travel needs are further categorized as follows:

- Advisory Information,
- En-Route Services Information,
- Emergency Assistance,
- Transit Information,
- Economic Development, and
- Data Sharing.

3.3.3 Traffic Management

Addressing Traffic Management needs in rural settings is important because while there is less congestion in rural areas than in urban and metropolitan areas, the lack of alternative routes when accidents or slow-downs (due to construction or seasonal congestion near tourist attractions) occur can cause many problems. Traveler frustration and delayed emergency response times are two of the most cited concerns regarding traffic congestion.

Specific Traffic Management needs are further broken down as such:

- Advisory Information,
- Traffic Control,
- Enforcement,
- Economic Development/Environmental Protection, and
- Data Sharing.

3.3.4 Rural Transit and Mobility

Like all other transit operators, those in rural settings must provide optimum service to their riders. These services may be fixed route, flexible route, demand-responsive, or traveler information options. Addressing the rural populations' needs must entail delivering service to a wide geographical area and a disperse population while still delivering a high level of service.

The FHWA document specified the following five categories within the Rural Transit and Mobility needs:

- Transit Management,
- Traveler Information,
- Electronic Fare Payment,
- System Operational Effectiveness, and
- Data Sharing.

3.3.5 Crash Prevention and Security

Because the severity of accidents can be magnified due to a slower response time inherent in the large geographical area and longer travel times, as well as the time it may take to discover and report an accident, Crash Prevention and Security is of paramount importance. This needs category overlaps with Emergency Services because both are concerned with travel safety. This category addresses factors before a crash happens and prevention, while Emergency Services deals with how to respond to accidents. The FHWA document identifies three components of vehicle crashes: the driver, the vehicle, and the roadway. All components must be considered when determining needs.

The following eight categories are identified in the FHWA document:

- Collision Avoidance,
- Roadway Geometrics,
- Roadway/Weather Information Systems (RWIS),
- Work Zone Control/Advisory System,
- Highway-Rail Intersection (HRI) Crossings,
- Vehicle Preemption,
- Security, and
- Data Sharing.

3.3.6 Operations and Maintenance

Rural transit operators face many challenges to operations and maintenance. These agencies are often small and do not have the funds or staff to function at levels similar to their larger, urban counterparts. Therefore, a handful of people must take on multiple responsibilities to keep the system running.

The following categories are areas of concern in this needs group:

- Infrastructure Management,
- Roadway Condition Monitoring,
- Safety Management,
- System Maintenance Effectiveness,
- System Operations Effectiveness,
- Public Fleet Management,
- Security, and
- Data Collection and Sharing.

3.3.7 Surface Transportation Weather

Weather monitoring is crucial in the prevention of accidents and for effective dispatch activities, especially in areas where severe weather can pose danger to lives and property. As stated in the FHWA document, "Rural user needs in the area of Weather focus on support to decision making prior to trip initiation, monitoring roadway weather conditions for trips and operations that are underway, and communicating this information to system users."

Below are the five categories of Surface Transportation Weather needs:

- Advisory Information;
- System Operational Effectiveness;
- En-Route Services Information;
- Leveraging Weather Information to Cost Containment, Profitability, and Safe Operations/Travel; and
- Data Sharing.

3.4 WEBSITES

In addition to reviewing reports and documents on the subject of rural ITS, the research team gathered information on existing and planned implementations, as well as information on larger federal or state ITS architecture, from various web resources. Many organizations and governmental bodies publish valuable information online, reducing the time necessary to gather data. The four most valuable websites were the following:

- The U.S. DOT's Intelligent Transportation Systems (www.its.dot.gov),
- APTA (www.apta.com),
- ITS America (www.itsa.org), and
- The Transportation Research Board of the National Academies (www.trb.org).

3.4.1 The U.S. DOT's Intelligent Transportation Systems (www.its.dot.gov)

The U.S. DOT's Intelligent Transportation Systems website provides information on implementations, programs, and initiatives throughout the nation. It focuses on the role of the federal government in implementing and assisting state DOTs with ITS projects and historical information on the development of national ITS planning. According to the U.S. DOT's website, the four key goals that guide the program are

1. To promote the implementation of a technically integrated and jurisdictionally coordinated transportation system across the country,
2. To support ongoing applied research and technology transfer,
3. To ensure that newly developed ITS technologies and services are safe and cost-effective, and
4. To create a new industry by involving and emphasizing the private sector in all aspects of the program.

In addition, the website has a section on rural ITS developments that lists publications, information on public hearings, and related links. The site also provides crucial information on the National ITS Architecture, how rural developments tie into this nationwide plan, and state implementations and progress.

3.4.2 APTA (www.apta.com)

APTA is a not-for-profit organization composed of transit professionals, vendors, and industry experts. Its mission is to share information with those who provide public transit services and the industry that supports them. The association also helps shape legislative policy that is central to federal funding of ITS, such as the Transportation Equity Act for the 21st Century (TEA-21) reauthorization.

APTA realizes the need to support rural ITS developments because individuals who live in small urban and nonmetropolitan areas are transit dependent. According to the Bureau of Transportation Statistics's 2000 Consumer Expenditure Survey, this segment of the population includes those in lower-income brackets, seniors, and mobility-challenged individuals who spend about 42 percent of their total annual incomes on transportation. This dependence, combined with the geographical challenges of a widespread service area, creates challenges to meeting the needs of the rural community. APTA continues to research this situation and provide resources to those who are looking to develop innovation in addressing the issue.

3.4.3 ITS America (www.itsa.org)

Founded in 1991 as an advisory committee to the U.S. DOT, ITS America is a not-for-profit organization that aids in the development and deployment of ITS in the United States. Its members include governmental agencies, private-sector companies, and academics. ITS America does not view ITS technology as innovative; rather, ITS America believes that the unique implementation of ITS technology to address specific transit needs makes the technology remarkable.

ITS America realizes that implementing ITS technology in rural settings is a potentially difficult task. Funds and expertise are often limited, but rural agencies can see the greatest return with implementations that do not necessarily have to be complex. Navigation systems, crash notification, weather tracking, and electronic fare payment are all technologies used by larger agencies that have practical and immediate applications for rural transit.

3.4.4 The Transportation Research Board of the National Academies (www.trb.org)

The mission of the Transportation Research Board of the National Academies is to promote innovation and progress in transportation through research. This mission is accomplished through standing committees and task forces that oversee research on all facets of transportation. The research is distributed to members of industry, academia, and government as decisions are being made on the nation's transportation infrastructure.

The organization's website has been an invaluable resource for previous research on rural ITS implementations. Many studies have been performed on specific locations and deployments. From this source, many potential agency contacts were found for this research.

CHAPTER 4

AGENCY FINDINGS

For this study, five rural agencies were interviewed. The agencies included in this report are the ones that were able to provide information at the time of writing. Because many other rural transit operators are implementing technology solutions, additional research should be performed to catalog such activities.

The majority of rural ITS implementations are overseen by state DOTs, and so the initial focus of the research was to gather information from the state agencies. Since local rural transit agencies usually do not have the funds or expertise to develop, procure, and manage an ITS solution on their own, the states have stepped in to assist the rural agencies in the development and procurement process. Therefore, many states are integrating the rural agency's specific needs with larger state-run procurements, thereby reducing necessary ramp-up time and deferring developmental costs. Also, because many states are in the process of implementing statewide ITS architectures, developing rural ITS infrastructures within the existing or planned statewide architectures will save integration costs and difficulties for all parties in the future.

Information gathered from the following organizations will be discussed in this report:

- Kansas DOT,
- Community Action Partnership of Mid-Nebraska,
- Iowa DOT,
- California DOT, and
- Oregon DOT.

Table 1 in the summary presents the technology and needs gathered from the organizations above. The table matches the agency's specific need to a specific ITS solution.

4.1 KANSAS DOT

In 1999, the Kansas DOT developed a statewide ITS plan that included provisions for rural transit. The Baseline Condition Report, Section 1, of this plan identifies state and Interstate routes and rural developments that are key to this plan because 97 percent of the total road mileage in Kansas is in rural areas. The ITS initiatives focus more on applying technology to support existing transportation objectives than on adopting unproven technology. The objectives for the state of Kansas are in the following areas:

- Emergency services,
- Tourist/traveler information services,
- Public mobility services,
- Commercial vehicle operations,
- Fleet operations and maintenance,
- Traveler safety and security, and
- Infrastructure operations and maintenance.

The Kansas statewide ITS architecture is currently being revised and developed. The timeframe for completion and deployment has been estimated as 5 to 10 years from the writing of this report.

Currently, the focus for rural ITS development has been on providing greater traveler information to both individuals who drive and those who ride public transportation. Rural transit agencies have been using a $2 million set-aside fund for the purchase of portable and overhead highway electronic message boards. These boards relay real-time traffic conditions, delays, weather warnings, and "Amber Alert" information for child abductions. Funds have also been used to develop 511 traveler information, a system that provides real-time traffic and related weather news 24 hours per day over the telephone or online.

Traveler information activities are currently coordinated through a centralized server in Topeka. This location manages the data for all 18 rural areas in the state. Options for future management of information systems include formalizing a central data center for operations, having a virtual center online with each rural region responsible for uploading information, or breaking up information outlet responsibilities by district. Any of these options would be approximately 2 to 3 years away from deployment.

In addition to traveler information, automated dispatch systems are being included in the statewide ITS infrastructure. Currently, a dispatch system from Trapeze Software Group is being used by select transit systems, with future plans to integrate throughout the state. This system uses state-owned communications lines, in-vehicle driver mobile data terminals (MDTs), automatic vehicle location (AVL), and automation software.

In summary, the goals of Kansas DOT with regard to rural ITS are as follows:

- Increased traveler information;
- Increased communication between travelers, dispatchers, and drivers;
- AVL;
- Rider convenience; and
- Value for the dollar.

All goals are traveler focused because ultimately the goal of any transit organization is to move people. Providing traveler information and automated dispatch with AVL serves the public without unnecessarily long development times.

4.2 COMMUNITY ACTION PARTNERSHIP OF MID-NEBRASKA

The Community Action Partnership of Mid-Nebraska is the only rural transit agency that presented direct information about its ITS implementation. This non-profit agency provides, among other services, on-demand transit services to approximately 1,500 riders with 85,000 boardings per year in a 954-square-mile area. It operates between 10 and 30 peak vehicles and has deployed a variety of ITS solutions to provide greater rider services.

The first technology implemented was automated dispatch software. Prior to the implementation in 2001, scheduling and dispatch coordination were done by hand and Microsoft Excel spreadsheets. This process was time consuming, led to errors, and was racked with so much inefficiency that 50 to 100 riders per day were turned away. Also, the required reporting to various state and federal agencies could take up to 2 weeks, thus taxing staff resources.

The scheduling software (provided by Easy Ride) reduced the amount of effort required to set up and dispatch a driver to pick up a rider. Multiple-leg trips could also be scheduled, and riders who called less than 24 hours prior to a pick-up could also be accommodated. These abilities greatly increased the convenience of the service, which in turn increased ridership, revenue, and return on the investment.

In conjunction with the new dispatch system, the Community Action Partnership is also deploying two web-based tools to aid in rider convenience. The first tool is an online ride request system where travelers can schedule pick-up times and locations through a Microsoft Exchange system. The other tool is real-time schedule downloads, which allow riders to know the exact status of their pick-up vehicle. A variety of vendors will be used to provide information over a virtual private network (VPN) in the immediate future.

The third component of this ITS solution will be the adoption of geographic information systems (GIS) and global positioning systems (GPS) to aid in the real-time deployment and tracking of vehicles. The GIS/GPS (provided by LTI Technology), along with AVL, relays information from an MDT onboard the vehicle on the exact location of a vehicle at any given time. This information is then uploaded via radio data transfer and used by the scheduling software to plan the most efficient trips. The real-time schedule is then provided to travelers.

The Community Action Partnership has a few partners in its technology implementation. The first partner is the Buffalo County Sheriff's Department. The partnership with the Sheriff's Department occurs because the Sheriff has in-depth knowledge of GIS and GPS. Because the Community Action Partnership has limited resources, subject matter experts are found in the local community wherever possible. The Sheriff's Department provides the expertise for the system and receives benefits because it can control the bus dispatch. This feature is important when emergencies occur because the Sheriff's Department can take control of the buses in times of natural disaster or for security reasons. Also, the Sheriff's Department provided $71,000 of the $150,000 necessary for this implementation.

The second partnership is with Metro Area Transit (MAT) in Omaha. During the procurement, the Community Action Partnership's MDT vendor went bankrupt, forcing the Community Action Partnership to look for other options. MAT was looking for partners for a statewide AVL/MDT system. A joint procurement, along with technology sharing, was agreed upon, though these projects have yet to come to fruition.

The Community Action Partnership's goal is to be fully integrated with neighboring areas and the state's ITS architecture by 2009. The original timeframe called for completion of the system by August 2003. This timeframe has been delayed to an unknown future date.

4.3 IOWA DOT

The Iowa DOT has made the commitment to develop and implement a Statewide Transit Intelligent Transportation System. Estimated funding for the project was approximately $3.8 million according to the January 2004 U.S. DOT ITS Project Book (www.itsdocs.fhwa.dot.gov). In 2001, Iowa DOT completed a statewide ITS deployment plan and hired a consultant in 2002 to further develop this deployment plan into a transit ITS plan. The goal of this plan, like other statewide plans, is to implement ITS technology to improve transit services, not simply to make technological progress. Also, the Iowa plan does not include hardware or software with widespread applications such as word processing, spreadsheets, and general database management as part of the transit ITS.

Iowa's transit ITS plan has two goals. The first goal is to develop a statewide architecture for deployment of ITS. The focus of this architecture is creating a system to allow the state to manage the implementations as a whole and to tie in each individual transit agency. The second goal is to develop recommendations for the 23 rural and non-urban transit agencies, as well as the 12 large urban systems.

The plan developers categorized technology into five groups:

- Fleet Management Systems,
- Operational Software and Computer-Aided Dispatching (CAD) Systems,
- Electronic Fare Payment Systems,
- Advanced Traveler Information Systems, and
- Transit Intelligent Vehicle Initiative.

In 2003, Iowa DOT progressed to the next step by issuing a "Request for Proposals for Iowa Statewide Rural Transit ITS Deployment." A consultant was selected and is now responsible for working with the 23 rural and non-urban transit agencies to implement proposed recommendations as well as integrate each agency into the statewide plan.

Iowa DOT has specific technologies that it would like to see implemented in the immediate future for its rural and non-urban transit agencies. The first is automatic scheduling and dispatch. This technology would provide more efficient, real-time customer response when tied into MDTs onboard vehicles. According to a recent article in *Passenger Transport* (July 26, 2004), RouteMatch Software, Inc., has been selected to provide the automated demand-response software solution. The company will standardize reporting functionality among the rural agencies and reduce system maintenance.

The MDTs represent another technology desired by Iowa DOT. These units would provide trip manifests and customer information to drivers and provide radio communications to central dispatch and AVL functionality. RouteMatch Software will also provide the MDTs, and Mentor Engineering will provide the wireless data systems for the communications link.

The third technology solution desired is automatic billing for paratransit and ride-on-demand services. This technology would streamline manual processes and provide uniformity to collections and reporting. Automatic billing is a key technology, as the majority of all rural and non-urban transit is demand-service based.

Interoperability between all local transit operators in the state is the basis of the statewide ITS architecture. The DOT has developed a template for agreements and contracts for ITS, and if the transit agencies would like to participate in the statewide programs, they must sign on and agree to its terms. At this time, each agency has a system that can only be accessed by that agency, and there is no sharing of information.

4.4 CALIFORNIA DOT

Like every other transit operator in the nation, those in California are looking for low-cost ITS technology to aid in providing streamlined services while reducing costs. Rural transit operators face additional challenges because the majority of services are infrequent or do not follow set schedules. To examine low-cost ITS potential in rural California transit, the California DOT, in conjunction with the California Polytechnic (Cal Poly) State University at San Luis Obispo and the City of San Luis Obispo Transit (SLO Transit), performed a study and field test called Efficient Deployment of Advanced Public Transportation Systems (EDAPTS).

The project team began by identifying areas where ITS would benefit rural and non-urban transit agencies. While EDAPTS was limited to the San Luis Obispo area, the results and findings were intended to benefit transit agencies of similar size and disposition throughout the state. The two main guidelines, as described in the California DOT website for the EDAPTS program, were as follows:

- ITS solutions must be (a) low cost, (b) easily configurable to local needs, and (c) non-proprietary.
- System performance trade-offs can be made to significantly reduce costs if they do not adversely impact the usefulness of the deployed system.

The team first met with stakeholders to discuss what was needed from the research. The team found that cost impacts must remain low from procurement to system maintenance, systems must be configurable to adjust to the growth of the transit agencies, and the solutions must be off-the-shelf technology that is easily replaceable and not subject to intellectual property restrictions.

The next step was to develop a conceptual framework for ITS solutions based on the FHWA National ITS Architecture Guidelines and the National Transit Coordinate Interface Protocol (TCIP) to ensure uniformity and compatibility with other systems. Open standard transit management software was developed by Cal Poly to govern the system. It was developed using open source code so that others can understand and adapt the program as necessary. The technology solutions also included

- AVL/GPS,
- Dynamic messaging signs for real-time information run on solar power,
- Central dispatch software and real-time web maps on bus locations,
- Silent alarms for emergency situations,
- Radio frequency modems for transmission of digital data over voice radio links,
- MDTs, and
- Card reader inputs for magnetic or electronic fare media.

Once the framework was developed, field testing on SLO Transit buses was performed to measure performance. The field tests were successful, showing that integrating low-cost technologies can lower life-cycle costs without impacting performance. The use of solar power reduced infrastructure costs by eliminating the need to install power conduit lines to multiple message signs. The transmission of data over voice radio channels eliminated the need to use expensive dedicated communications lines for these activities. The use of non-proprietary, off-the-shelf components kept costs at a minimum due to the competition among manufacturers' widely available equipment.

There are currently no clear plans for the full deployment of the EDAPTS SLO Transit test systems. In fact, no schedule was developed, and a problem statement for the implementation was only developed recently for the 2005–2006 budget year. However, the general consensus from the California DOT is that this implementation is happening more slowly than expected because the lack of a clearly defined schedule and a loss of base funding for SLO Transit's evening services reduce the collected data on performance effects. The implementation should speed up with the newly developed problem statement. Funding for the current phase of the program is estimated at approximately $1 million, with anticipated costs of the next phase approximately $400,000. The majority of the money will be provided by the state.

Because the system may be adopted by other rural or nonurban transit operators, system control will not be centralized by the California DOT. The California DOT will provide guidelines and structure, but operations control will remain in the hands of each individual transit agency or governing body as agreements dictate.

4.5 OREGON DOT

The Oregon DOT (ODOT) website reports that nearly one-third of the state's population is "transportation disadvantaged." This means that these individuals rely on others to get to their destinations, whether by public transportation or private accommodations. Transportation-disadvantaged individuals include seniors, people with disabilities, and lower-income families who do not own a vehicle. ODOT expects this number to grow another 50 percent in the next 20 years.

As such, ODOT has made the commitment to improve transit services to its population, including rural and nonurban communities. Part of this commitment includes the development of a regional trip-planning website, www.TripCheck.com. Through this site, passengers can get real-time information on services, plan trips end-to-end, and pre-pay for services. This program was initially an ODOT project, but the state of Washington has expressed an interest in participating as well.

The first phase of the deployment is currently underway, with the first release of the system expected to be completed by summer 2005. This $1.5 million development will allow website visitors to schedule trips using a variety of transit sources, including fixed-schedule services, demand-responsive services, heavy rail, and shuttle/taxi services. The website uses GIS-based map information provided by the transit operators to aid customers. Therefore, a customer can plan a trip, using several transit agencies, and all trip information is available online interactively. This tool is valuable for people needing to use several services because it aids in the coordination of connections in an interactive fashion. Initial evaluations have shown that there is a strong desire for such information. Future functionality of full itinerary building and electronic fare payment (second phase of deployment) is highly desirable. Eventually, an individual will be able to plan entire trips across the states of Oregon and Washington as well, with times and connections clearly defined.

With proper information resources available to customers, ODOT expects to see an increase of 5 to 13 percent in ridership. Information will be uploaded to a central server, though it will be the responsibility of each transit agency to ensure that the information is correct. Uploading information to a central server will require a great amount of coordination, as Oregon alone has over 200 public transit agencies. The architecture will be based on open national standards to ensure compatibility with the National ITS Architecture. No vendor is currently selected to develop the front-end user web application. However, with a clear goal and steady progress (the program has been ongoing for 5 years, with user case sessions being completed), success will be attainable. Because rural transit agencies are already stakeholders in this development, integration into a larger statewide system is guaranteed.

CHAPTER 5

TECHNOLOGY CONSIDERATIONS

The ITS technologies previously mentioned have all focused on providing greater service and more useful information to travelers in the region. Web-based applications further serve this goal, with applications available to both passengers and transit agencies. However, technology considerations other than web-based ones also affect the most successful use of technology. Back-end systems must be developed to handle web queries, data uploads and downloads, and communications exchanges. The following are areas of consideration when planning an ITS implementation:

- Wireless communications,
- CAD,
- AVL,
- MDTs,
- Accounting and reconciliation,
- Online customer service centers, and
- Electronic fare collection.

A transit agency must consider many factors when choosing which of the above technologies to invest in. Some of the above technologies will not be cost-efficient, or the benefit they provide will not solve a significant problem for the particular transit agency. Therefore, each agency must consider its needs carefully to determine if the technology

- Will solve the agency's problem,
- Will provide more than the agency needs, and
- Will cost more than the agency can afford.

The analysis below reviews each of the technologies presented and determines what benefits the product will give, what additional infrastructure is required, and what cost is involved. The cost of each technology is only a rough idea; each agency or state will negotiate its own price based on the number of items purchased and the technology and vendor used.

5.1 WIRELESS COMMUNICATIONS

Communications systems form the backbone of any technological fleet application. Information must be transmitted from dispatch centers to drivers and from vehicles back to central systems. Communication from the driver to the head office will allow the dispatcher to know where each transit vehicle is, and the agency can use that information to coordinate the routes taken. Communication from the dispatcher to the driver informs the driver where to go, in the case of on-demand systems, and give traffic information and other updates in the case of fixed routes. In either case, the information can be verbal or visual if the system includes an MDT.

The communications systems can be as simple as two-way radios where the dispatcher and driver relay information about pick-up appointments, vehicle location, and status. The systems can also be more complex and use Cellular Digital Packet Data (CDPD). CDPD is a communications system that sends out bursts of data. When combined with AVL/GPS and MDTs, this data system is extremely useful in sending information automatically to a receiver without distracting the driver. The information can be stored as a manifest to the driver on the MDT, provide directions to pick-up locations, and provide vehicle status and location information to the central system. This information received by CDPD can then be uploaded to a website to provide real-time information to travelers. Digital data over voice radio systems, such as the one used in California, can provide a low-cost alternative to CDPD while still providing the same basic functionality.

Digital radios allow data to be transferred via satellite to remote locations. Therefore, the control center can transfer a manifest to a bus in the field, giving the driver directions to the next patron pick-up. The driver does not have to answer a radio or write down directions himself, and the patrons can request service just a few hours prior to the pick-up because the information can be available for the driver instantaneously. Of course, with satellite feed there may be shadows and dead spots where a transmission will not work.

Wireless communications is the backbone of ITS because communications with the vehicles is central to the operation of a CAD system, AVL, and the MDTs. Without the wireless communications technology, none of the other systems will function because they depend on communication with the vehicles. Therefore, wireless communication is almost essential for efficient use of ITS for a rural agency.

5.2 CAD

Many of the agencies listed in Chapter 4 have implemented or are considering CAD solutions to providing greater service to riders. CAD helps to coordinate and automate dispatching so that the most efficient schedules and pick-up locations are used for on-demand services. Manual entry of information can be reduced or eliminated, and multiple legs of trips can be scheduled simultaneously. Because automatic or semi-automatic scheduling increases the speed with which trips are scheduled, agencies can offer greatly increased response times. Therefore, agencies that at one time required a 24-hour advance notice can now offer patrons same-day service. This ability increases ridership as well as patron satisfaction.

Functions can be added to a basic system that will check for patron eligibility (in the case of ADA trips), present vehicle location on a layered map, or even warn of a patron's history and any possible problems. Most systems track recent rides to the individual, confirm addresses, allow "what if" questions, and provide redundant-reservation warnings. A fully automated software system can generate a full schedule and dispatch arrangements without human intervention. However, an AVL system is required as well as the CAD system so that the location of each bus can be determined to create the most efficient route.

When combined with online applications, CAD systems can be used to fully automate the scheduling function. Passengers can plan trips online, and this information can be forwarded to drivers for the automatic creation of trip manifests. Also, when used in conjunction with an MDT, dispatch information can be relayed to a driver in real time, allowing for greater responsiveness while still planning efficient routes.

CAD systems vary in costs, depending on the sophistication of the existing equipment and what additional systems are included. For a small rural agency (350 rides per day), a system may cost between $75,000 and $245,000 to install.

CAD systems seem to be the best use of a rural operator's ITS dollars. The ability to automate the scheduling functions, even if that information must be passed manually to the drivers, allows the agencies to increase patron satisfaction by reducing the lag time between ordering and receiving that service. It also allows the agencies to lower their own costs by streamlining their operations and choosing more efficient routes.

5.3 AVL

AVL systems provide yet another useful tool in the efficient management of services. An AVL system permits centralized and automated determination, display, and control of the multiple vehicles over a large area. Therefore, the control center can locate and plan the route of any vehicle as well as determine the most efficient use and route for each trip. Calculations can be made by distance and by average traffic speeds per time of day to give patrons a convenient and accurate online tool (if a website is used for customer service) for assessing wait times for on-call services. Dispatchers can send a vehicle that is closest to the pick-up location without having to call each driver to status location. Less time is wasted for all parties, and fuel resources are conserved.

There are three ways to track vehicles: GPS, LORAN-C technology, and signpost technology. GPS is the most efficient technology for transportation that requires variable routes because it uses satellite triangulation to find the exact location of an object or place. For transit applications, a GPS module is integrated into the vehicle and measures the distance to three satellites in orbit to find an exact position relative to those three satellites. This GPS module provides the AVL functionality to the transit agency, allowing the agency to monitor a vehicle's travel and progress. AVL is also a useful tool for security, allowing the agency to locate a vehicle in emergency situations such as accidents in remote areas or hijackings. An AVL system can cost from $400 to $2,000 per vehicle, with the back-end system costing about $10,000.

An AVL system seems to be one of the better uses of rural ITS dollars. The ability to track vehicles allows the control center to more effectively plan and use its resources. The technology depends on wireless communications systems to transmit the information to the control center, so this additional ITS equipment is necessary to make the AVL system effective.

5.4 MDTS

MDTs are being adopted across the nation to provide drivers information on routes, traffic conditions, and weather updates. An MDT is basically an onboard computer unit that displays relevant information to the driver in either text or graphical form. The data are received from the control center through the digital radio receiver. AVL systems can be integrated into the MDT. Other potential functionality includes a keypad so that drivers can input necessary information and control the fare collection functions of an automatic fare collection (AFC) system, if desired.

An MDT eliminates the need for transit drivers to rely solely on voice radio communication for information. Dispatch messages can be sent to the MDT and reviewed by the driver when driving conditions are safe instead of the driver being distracted while driving. Also, security, roadway, and directional information can be reviewed on the MDT. The MDT can send vehicle location, passenger counts, engine performance, mileage, and other information to the control center. The MDT can replace the need for the driver to take notes or write manifests. The MDT is a useful ITS tool for the rural agencies, but it is not essential.

5.5 ACCOUNTING AND RECONCILIATION

In many rural agencies, fare reconciliation and general accounting are performed manually. This consumes staff time, creates errors, and does not allow for easy manipulation of data. Software packages can be purchased to automate many of the functions currently performed manually. Each agency must decide which automated functions will best serve the agency's employees and save resources. Some factors to be considered are the amount of staff time spent on accounting, the need for better statistics, and faster error-free reconciliation.

AFC systems can be installed that will count fares as they are inserted, electronically transfer that information to a back-end system once the vehicle returns to the garage, count the currency when it is retrieved from the fare collection boxes, and provide statistics to the agency. Software or back office systems can assist with payroll and schedule employee shifts and equipment maintenance. The cost of each electronic accounting system varies widely, from a minimum investment of $119 for QuickBooks Basic to perform basic accounting to several thousands of dollars for coin-counting equipment and software.

For agencies in regional or statewide interoperable agreements (i.e., agencies that have fare media such as smart cards or magnetic cards that function as payment for more than one agency), payment and reconciliation systems are especially important in the distribution of funds. If the accounting system is centralized, then the dispersal of monies collected based on ridership is easily calculated. If each system is run independently by transit agencies, but travel on multiple lines is an option, then the agencies must reconcile collections and transfers.

5.6 ONLINE CUSTOMER SERVICE CENTERS

Internet purchases are now more secure than ever, with encryption technology protecting sensitive personal information. Many large transit agencies have invested in online customer service systems that allow patrons to plan trips and in some cases purchase tickets with credit cards. These web-based applications can be changed hourly for such things as weather updates (511 numbers) or other information.

Online customer service benefits riders because they have information at home or work and can use the Internet to plan their trips. If the system includes a ticket purchase selection, the patrons do not need to bring correct cash fare payment and the transit agencies collect funds up front. Also, automatic billing of transit services reduces the amount of coordination and reconciliation effort needed to pay for such systems.

The price of a web-based application depends on the complexity of the system. If outside server space is rented, that cost will be added to the operations and maintenance system (such as credit card links and links to other transit agencies).

Another caveat that the agencies must consider is the populations they serve. Often rural patrons are older and/or poor. Elderly patrons tend to view web technology with trepidation and fear, and those below the poverty line often do not have the resources to have access to computers. Rural areas often do not have the infrastructure to allow for Internet access or only allow for very slow and intermittent connections.

5.7 ELECTRONIC FARE COLLECTION

Larger transit agencies have already adopted electronic AFC systems. Rather than collecting fares manually, an electronic fare box accepts, counts, and controls the fare as the patron presents magnetic or smart card fare media to enter the system. AFC systems usually offer the advantage of a time-based or ride-based pass that can be used with the equipment to automatically deduct fares or confirm the validity of the pass. All these systems have the goal of eliminating the need for cash for each trip, with fund values stored on the fare media. The other primary advantage of AFC systems is that they allow for greater data collection activities, automatically collecting the data required to make service decisions and analyze rider habits and traffic patterns.

For rural agencies that offer non–fixed-route rides, AFC equipment may not offer much value. If routes and rides are processed through a customer service center of some type, statistics will be gathered at the point where the patron calls for the ride rather than at the point of entry. Further, when rides are spaced out and therefore service is less intensive, manual fare collection and reconciliation is less of a burden on transit staff than on a fixed-route system.

For fixed-route systems, an AFC system may present time savings (fare reconciliation is much easier) and valuable statistics. Statistical information that can be collected from an AFC system includes time and date, number of riders entering the system at each stop, what fare is collected, and the type of payment (if other than cash). Transfers are also encoded or recorded so that movement between routes can be determined.

An AFC system can remain cash only, accept tokens, or use other electronic fare media. An AFC system with electronic fare media of any type requires additional equipment. Some form of fare media dispersal equipment is necessary to get the tickets into the hands of the people who purchase them. Either this equipment can be a transaction between a customer and human agent or the transaction can be completed using an automated vending machine. In addition, back-end computer systems must be included so that data collected from a fare media sale can be recorded.

Magnetic tickets have been used for transit applications since the early 1970s. Only a very limited amount of information can be stored on the card—generally just a serial number, the entrance or exit code of the last point of use, and the purse amount (or pass date). This information can be destroyed if a magnet comes in contact with the card. Also, magnetic cards are fairly easy to duplicate, so fraud is an issue.

One of the most promising new forms of fare media is the smart card. A smart card is a microprocessor-embedded piece of plastic or paper the size of a credit card with a radio frequency antenna (contactless version) or contact points (contact version) that transmit data. Smart cards hold relatively large amounts of data securely. With the development of regional interoperability programs, a smart card can be used by a patron on multiple transit systems, adds conveniences such as an automatic loading of funds to the card when linked to an account, and has potential retail applications beyond transit. The card can also be used for access to facilities like community centers and libraries. Also, major financial institutions such as Visa and MasterCard are developing smart card technology. Using a system developed by these large financial institutions can reduce the necessary development cost to implement such a fare solution.

Both the magnetic and the smart card tickets provide convenience for the rider. The rider does not have to carry cash, and, in the case of smart cards, the card can be replenished over the Internet.

A rural agency must do a cost benefit analysis to determine if an AFC system is feasible. An electronic fare box that collects and reconciles ridership records, provides statistical information, and reads and writes magnetic tickets can retail for approximately $10,000. The cost to add a smart card reader is between $2,000 and $3,000 per fare box. The back-end system will cost between $100,000 and $200,000, depending on the technology chosen. Finally, the ticket vending machines cost approximately $30,000 per unit, not including the infrastructure (i.e., communications wire to connect with the network).

CHAPTER 6

ANALYSIS OF SOLUTIONS

Because of limited funding, rural transit agencies are not using new technology to the extent that their larger counterparts are; in fact, very few of the rural transit agencies have plans to incorporate ITS. Funding for new equipment is scarce, the equipment is often more expensive for a small agency (because small agencies cannot bargain for a discount based on volume), and the infrastructure required to install the equipment is more extensive. The rural agencies do not have the technical expertise to evaluate the technologies, and they do not have the purchasing power. Because a small agency does not have a great deal of electronic equipment, it will probably not employ a high-level technician who is familiar with new technologies (there is simply no need for the expert). Further, the volume discounts and customer service available to the agency procuring 250 digital radios is not available to the agency purchasing 5.

All of the rural systems discussed in this report are being assisted at the state DOT level. In each case, the state is funding a program to bring ITS to the rural agencies. In one case, the state even sets up the procurement for the small agencies to buy into if they want. There are some very positive results from this alliance between the state DOTs and the rural agencies.

If a state DOT becomes involved with a procurement and offers that procurement to all the rural agencies in the state, the procurement grows to a size that will then interest vendors. Therefore, the price of the equipment will drop and become more available to the rural agency. If the state DOT evaluates the offerings of ITS solutions, then that information can be passed to the smaller agencies, eliminating the need for each agency to perform its own investigation.

Further, if all the agencies in one state have the same system or equipment, communications and interoperability between those agencies become much easier. Having the same system or equipment permits the information to flow between those agencies in a seamless fashion and allows agencies to blend services if and when the agencies feel it is in the customer's best interests. Therefore, there may be a "route planning" program for the entire state that combines information from all the agencies, or there may be a smart card that can be used throughout a state.

Having interoperability as an achievable goal for the particular state and agencies may be a way to persuade the federal government to contribute additional funding. The goal further supports current federal initiatives for regional solutions and standards.

However, if the state DOT is responsible for the procurement, the rural agencies lose much of their ability to customize the procurement for their own particular needs. The agencies have choices available to them only through the DOT. State concerns replace rural concerns when the needs are assessed. As long as the DOT and the rural agencies work together, this issue will not hinder the procurement of the technology.

CHAPTER 7

CONCLUSION

When evaluating the potential adoption of ITS technology, each rural agency must have a clearly defined set of needs. The technology should be chosen to closely fit the needs of the agency, as well as fit within the budget of the agency. Technology should be adopted to increase transit service and not to prove the latest and greatest ideas. ITS solutions should be specifically matched to address a real and definable need, and the effects of ITS solutions should be measurable and quantifiable.

The most prominent need that all the agencies expressed for this report was reducing the time to schedule trips and streamlining the process of planning trips. Transit agencies are looking for ways to improve dispatching that does not require manually planning trips. CAD programs help to automate this system and plan the most effective routes. This leads to greater responsiveness to passenger needs while reducing agency effort. Therefore, most agencies put CAD systems high on their list of improvements.

In order to make CAD systems effective, agencies must have digital communications, so that electronic manifests can be transmitted to the vehicles as soon as the trip is requested by the patron. The accompanying piece of technology is the AVL system, which allows the scheduling software to determine where the vehicle is in order to create the schedules and routes automatically. Therefore, digital communications and AVL work in conjunction with the CAD systems to create a fully automated and efficient scheduling system.

Accounting and reconciliation programs save time for staff and add accuracy and flexibility to the accounting process. The use of such programs will vary with the agency: the smaller the agency, the less cost-effective an accounting system will be. Accounting systems can be installed at any time. Because accounting information is less likely to be shared in any kind of joint interoperable or regional system, compatibility between systems is not important.

Online customer service centers are very effective for large urban areas where the transit population is likely to have access to personal computers and knowledge of how to use them. These systems are less effective in rural settings where the transit patrons tend to be low income and elderly and therefore possibly more intimidated by computers. Also, many rural areas have not yet invested in the infrastructure necessary to create seamless Internet service, so access may be a problem. However, statewide customer service centers may shift the burden of the cost to a more urban center, yet allow rural systems to join and receive some benefit from such a product. Therefore, online customer services centers may be effective for a rural agency, but will probably be more effective if a larger area becomes involved for small agencies.

Electronic fare collection systems are probably not cost-effective at this time for rural agencies. The cost of such a system is very high compared with the benefit received.

It is important for rural and non-urban transit operators to remember to partner with state agencies when developing an ITS plan. As integration with state and National ITS Architecture is eminent, it is best to develop systems using open standards and established guidelines. This way, integration is more easily achieved. Also, state agencies and DOTs have financial resources and subject matter experts that rural and non-urban transit agencies may not have access to, so it is best to consolidate efforts to eliminate redundancy and reduce funding expenditures.

State agencies and DOTs are not the only groups with whom rural and non-urban transit agencies should consider partnering. Neighboring agencies and non-traditional stakeholders such as universities and law enforcement can provide additional resources, such as insight into solutions that may not have been considered. Unique approaches can be discovered when the knowledge base is expanded.

Additional research is necessary to fully expand the ITS developments in rural America. This report provided a sampling of the activities underway and a reference point for those wishing to undertake a similar approach. State ITS architectures are in development, and using those schemas seems most prudent. This use will ensure full integration with statewide plans and help to ease the financial strain on rural and non-urban agencies that want to adopt ITS solutions to provide better service.

Jeffrey Rumery, the Transportation Director of the Community Action Partnership of Mid-Nebraska, had the following advice: "Do not fall in love with your ideas. Be willing and open to change. The technology field is not like transit. Rural transit normally revolves around doing a lot of repetition and doing things the same way. Technology is a field that moves and changes, almost by the minute. Be prepared to throw out schedules and adapt. There is no such thing as perfect technology and there never will be."

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Abbreviations used without definitions in TRB publications:

AASHO	American Association of State Highway Officials
AASHTO	American Association of State Highway and Transportation Officials
APTA	American Public Transportation Association
ASCE	American Society of Civil Engineers
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
ATA	American Trucking Associations
CTAA	Community Transportation Association of America
CTBSSP	Commercial Truck and Bus Safety Synthesis Program
DHS	Department of Homeland Security
FAA	Federal Aviation Administration
FHWA	Federal Highway Administration
FMCSA	Federal Motor Carrier Safety Administration
FRA	Federal Railroad Administration
FTA	Federal Transit Administration
IEEE	Institute of Electrical and Electronics Engineers
ITE	Institute of Transportation Engineers
NCHRP	National Cooperative Highway Research Program
NCTRP	National Cooperative Transit Research and Development Program
NHTSA	National Highway Traffic Safety Administration
NTSB	National Transportation Safety Board
SAE	Society of Automotive Engineers
TCRP	Transit Cooperative Research Program
TRB	Transportation Research Board
TSA	Transportation Security Administration
U.S.DOT	United States Department of Transportation