U.S. Department of Transportation
Federal Highway Administration

Federal Transit Administration

SMALL URBAN AND RURAL ADVANCED PUBLIC TRANSPORTATION SYSTEMS

Prepared for

The Federal Transit Administration
US Department of Transportation
Washington, DC 20590

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February 1999

ITS Joint Program Office

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1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.

4. Title and Subtitle
Small Urban and Rural Advanced Public Transportation Systems

5. Report Date
August 1998

6. Performing Organization Code

7. Author(s)
John R. Stone and Anna M. Nalevanko

8.Performing Organization Report No.

9. Performing Organization Name and Address
Department of Civil Engineering
North Carolina State University
Raleigh, NC 27695-7908

10. Work Unit No. (TRAIS)

11. Contract or Grant No.
NC-26-7003

12. Sponsoring Agency Name and Address
Federal Transit Administration
Advanced Public Transportation Systems Division, TRI-11
400 7th Street, SW
Washington, DC 20590

13. Type of Report and Period Covered
Final Report

14. Sponsoring Agency Code

15. Supplementary Notes

16. Abstract
For small urban and rural public transit operations the challenge is to improve passenger service while maintaining acceptable system productivity and costs. To meet that challenge, more and more transit managers are turning to Advanced Public Transportation Systems (APTS). To apply APTS technology the managers need product information, case study experiences and peer contracts, guidance on acquiring the APTS product that match their transit system needs, and the expected payoffs and potential problems that may result. This report provides that information. Readers are invited to use the APTS technology decision tool that implements the findings of the project. The decision tool and supporting APTS information are at the following Internet address:
http://www2.ncsu.edu/eos/service/ce/research/stone_res/tahmed_res/www/index.html

Key Words
Advanced Public Transportation Systems, Rural Transit, Dispatching and Scheduling

18. Distribution Statement

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No of Pages	22. Price
Unclassified	Unclassified	143	

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

Preface

For small urban and rural public transit operations the challenge is to improve passenger service while maintaining acceptable system productivity and costs. To meet that challenge, more and more transit managers are turning to Advanced Public Transportation Systems (APTS). To apply APTS technology the managers need product information, case study experiences and peer contacts, guidance on acquiring the APTS products that match their transit system needs, and the expected payoffs and potential problems that may result. This report provides this information.

The preparation of this report was sponsored by a grant from the US Department of Transportation, Federal Transit Administration, Advanced Public Transportation Systems Division. Principal investigator for the project was John R. Stone, Department of Civil Engineering, North Carolina State University, Raleigh, NC. Anna Nalevanko, Transit Operations Group, NCSU Institute for Transportation Research and Education was co-principal investigator. Research Assistants were Tahsina Ahmed and Aaron Frank

The authors wish to thank Ron Boenau, Chief of the FTA APTS Division and Sean Ricketson, who were the project managers. Their support and direction of this project are greatly appreciated.

Readers of this report are invited to use the APTS technology decision tool that implements the findings of the project. The decision tool and the entire project report are at the following Internet address:
http://www2.ncsu.edu/eos/service/ce/research/stone_res/tahmed_res/www/index.html.

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Abstract

Advanced Public Transportation Systems (APTS) enhance public transportation in small urban and rural areas throughout the U.S. These technologies include computer-aided dispatch and scheduling software, automatic vehicle location via satellites, mobile data terminals for digital communication, electronic fare cards for billing, cellular communications, Internet technologies, and others that emerge from the laboratory every month. However, transit operators, especially those who operate smaller systems, experience technical and institutional difficulties in choosing, implementing and integrating these promising technologies. Installing advanced technologies is quite complex and expensive, and transit operators of smaller systems often lack the technical expertise to make informed decisions.

Thus, this report reviews the state of APTS technology and organizes it for use by small urban and rural transit operators. The information includes a spectrum of software and complementary hardware products. Product characteristics, costs, and vendors appear in tables throughout the report. Procurement and implementation guidelines in "check off" format appear at the end of the report. Furthermore, an Internet site summarizes the content of this report and provides a handy reference for APTS technology. The address for this site is:

http://www2.ncsu.edu/eos/service/ce/research/stone_res/tahmed_res/www/index.html.

To facilitate the proper use of this information and to match appropriate technology to specific transit agency needs, the report and Internet site model the decision problem facing transit managers seeking to upgrade or implement new APTS technologies. The Internet site mechanizes the model as an interactive, decision support. When the transit operator answers questions about the operating characteristics and other factors, the decision tool recommends appropriate APTS technology. Case studies validate the decision tool in various operational settings including those with high and low growth rates, fringe development, tourist areas, and rural to metropolitan commuters. Case studies document the impacts and compatibility of advanced hardware and software technologies and provide the "knowledge base" for the decision tool. Transit operators can compare their needs and experiences with others through a variety of "lessons learned."

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Section 1
Introduction

The premise of this report is:

Improved passenger service and system productivity can be mutually accomplished by appropriate application of Advanced Public Transportation Systems (APTS) technology.

Transit managers, vendors and researchers at a Transportation Research Board workshop entitled "Developing and Disseminating Creative Paratransit Operations Ideas" strongly echoed this premise (Monterey, 1997). During round table discussions the workshop participants related how they defined operational problems, service and productivity objectives, and successful approaches for providing transit service. Often the creative operations ideas involved APTS technology. Yet they did not find APTS a panacea for all operations problems or an easy remedy to achieve. During the scheduling and dispatching sessions, especially, it became very clear that managers of smaller transit agencies need guidance for acquiring expensive, complicated hardware and software. As one of the action items coming from the workshop, the participants called for better dissemination of information on the state of APTS technology, more cost-benefit and performance impacts of APTS technology, and guidelines to help transit managers make informed decisions. The TRB Committee on Paratransit, FTA, Project ACTION, Community Transportation Association of America, and California Association for Coordinated Transportation sponsored the workshop.

This report responds to issues raised at the Monterey TRB workshop in much the same fashion as the workshop attendees. From the perspective of small urban and rural transit operators in a variety of operational settings, the report discusses the problem of providing good customer service while maintaining good system-wide productivity – contradictory objectives. It illustrates various approaches to simultaneously accomplishing these objectives with case study interviews that provide "lessons learned" for application by transit managers seeking to implement new APTS technology. The report combines the results of the interviews with information on hardware, software and emerging technologies for transit operations so that in one document transit managers can "design" and "customize" APTS solutions for their particular operational problems. To efficiently disseminate information, a web site for this project presents the report and guidance on selecting APTS solutions for specific local operational and service problems http://www2.ncsu.edu/eos/service/ce/research/stone_res/tahmed_res/www/index.html.

Yet, while the focus of this report is on the service and operational objectives of the local transit manager, the national perspective cannot be ignored. At no other time in the past decade has public transportation received as much attention or funding as a bona fide transportation option for working commuters, as well as human service agency passengers. Most importantly, public transportation continues as an implement of public and political policy as it seeks to provide access to work opportunities for welfare recipients.

Subsequent sections of this chapter discuss the new challenges for small urban and rural transit operators. They define the operator and passenger "markets" for APTS technology, and they describe the potential cost savings from implementing new APTS solutions. The narrative provides details on the decision problems facing operators in various operational settings. With such justification as background, the chapter ends with a definition of the scope and objectives of the report to provide more and better information on APTS alternatives and guidelines for choosing and acquiring the technologies.

1.1 Problem Statement

Transit operators in small urban and rural systems face new challenges to provide not only traditional dial-a-ride medical and human service transportation, but also ridesharing and vanpooling and a variety of contemporary transportation services. Recent presidential policies have focused the nation's attention on the critical need for better welfare-to-work transportation. Continuing demographic trends foretell the growing need for transit to provide transportation to a growing elderly population. Simultaneously, a growing segment of young professionals and their children are "escaping" the city and settling in fringe and rural areas, and they need more and better public transportation. And some once-rural areas are developing into major tourist and recreational retreats that demand public transportation to overcome congestion problems usually associated with big cities.

As a result, many small urban and rural transit operators are finding that they are becoming full service mobility managers. Their passengers are demanding better service, better access, faster response and delivery, and even increased comfort. More and more the new transit clientele expect service approaching that of taxis, if not that of a private automobile. The end is fast approaching for yesterday's way of doing subscription reservations and day-before booking. Soon real-time dispatch will become the standard. Gone will be the tedious record keeping and billing that have plagued transit managers for years. Instead, smart cards will track transportation use and automatically debit or bill the rider or sponsoring agency. Crackling radios and muffled driver responses are fading and being replaced by silent digital communications. And satellites are helping to track the instantaneous location of each vehicle and passenger. And with automatic vehicle location technology satellites help to define the exact location of each origin and destination and provide precise measurements of the distance traveled by each passenger and vehicle.

Transit managers feel the lure of such APTS technology as they fulfill their new roles as mobility managers and seek to meet the new demands of their growing clientele. They understand and believe that APTS technology will provide the solution to their productivity and service problems, access and response objectives, capacity constraints, budget limitations, etc. Yet, most managers lack access to adequate, substantiated information to help them make knowledgeable decisions to improve their own operations. This report will present such operator-specific information.

1.2 Scope and Objectives

This report will help the transit manager of relatively small operations who faces technology decision problems. It focuses on small urban and rural transit operations that include traditional dial-a-ride transportation for human services, welfare-to-work transportation, and commuter transportation. It is generally applicable to paratransit, fixed route, and taxi transportation.

The broad goal of the project is to make APTS technology decision problems easier for the small urban or rural transit operator. It is not the purpose of this study to rank the various software and hardware available from vendors, nor is it the purpose of this study to provide an absolute answer to technology questions. Rather, this study is a guide for comparing and selecting APTS technologies.

The specific objectives of the study can be summarized as follows:

- To define the problems that small urban and rural transit managers face as they seek to apply APTS to their services.
- To identify decision issues (including operators and passengers) relevant to APTS hardware and software selections.
- To identify appropriate technology choices for small urban and rural transit managers considering such factors as the local transit market, types of passenger trips, size of the transit fleet, and staff capabilities.
- To review the state-of-the-art of APTS and related emerging technologies.
- To document APTS case studies and "lessons learned" for small urban and rural transit systems.
- To develop and demonstrate an assessment method to help managers of small urban and rural transit systems match their service needs to appropriate technology options.
- To provide access to the assessment method and related APTS information on the Internet.

1.3 Technology Decision Issues for Small Urban and Rural Operators

A number of questions confront transit operators as they seek to appropriately apply advanced public transportation systems (APTS) to improve passenger service and operating efficiency. These questions relate to the transportation role for smaller operators, the passenger markets they serve, and the technology choices available to them. The subsequent discussion addresses these questions with an emphasis on local passenger needs and local transit operating characteristics. To help place local issues in a national context, refer to Appendix 1.

What role will APTS technology play in rural and small urban public transportation?

Against the backdrop of small urban and rural transit needs and in expectation of rising funding levels for small urban and rural transportation (Appendix 1), transit managers look to the future and improving transportation for their passengers. One approach for guiding transit managers is the USDOT strategic plan for implementing Intelligent Transportation Systems (ITS) including APTS in rural areas (http://www.its.dot.gov/rural/docs/stratpln.htm#intro). The plan represents the USDOT perspective on rural ITS and the roles and responsibilities of DOT in improving the rural transportation system through advanced technologies. It identifies where USDOT will work to bring rural ITS technologies to maturity and what institutional arrangements for their deployment are feasible. The goal is to develop "seamless and integrated" transportation from rural to urban areas.

Such a plan is particularly important because it systematically organizes USDOT resources to respond to the rural and small urban transportation needs outlined above, and it provides a general policy for transit managers to follow as they employ APTS technologies to meet transportation needs of their passengers. This type of national level planning and policy document, however, does not match local transit needs to appropriate services, technologies, and resources. to improve both passenger service and system efficiency. It is not meant to provide quantitative benefits and cost estimates to transit managers to help them improve their local service and productivity. Unfortunately there are few other documents available that give detailed, or even summary APTS cost and benefits decision information to transit managers. Those that are available include Stone, 1995; Kihl, 1996; and Casey, 1997. The scarcity of existing analysis and quantitative evaluation of APTS capabilities in the rural and small urban environment presents a major knowledge and information gap for investment decisions.

Subsequent sections of this report will help fill the information gap. The report will provide APTS software and hardware information, vendor contacts, transit operator contacts, and practical advice on how to match appropriate APTS technology to local objectives for customer service and system productivity. Representative case studies describe real experiences and "lessons learned" so that small urban and rural transit managers can make good choices.

What APTS technology choices face small urban and rural operators?

Within the past ten years, there has been steady growth in the use of advanced communications and information technology systems in public transportation operations. The technologies include both software and complementary hardware systems that must be integrated to achieve the objectives of the transit system. Among the various technologies the most widely used, at least for larger paratransit systems, is computer-aided dispatching and scheduling software (CADS). The software combines and automates many scheduling, dispatching, record keeping, and billing functions. Depending on fleet size, ridership, passenger characteristics, operational factors, fares, billing policies, etc., CADS software with more or less sophistication and cost may be chosen by transit managers. Software options in decreasing level of complexity and cost are the following:

- Fully automated computer-aided dispatch and scheduling software (CADS),
- Semi-automated CADS,
- Custom database applications, and
- Off-the-shelf software.

There are also the complementary hardware technologies. Some of the most popular among larger operators include (Section 2):

- Automatic vehicle location (AVL),
- Mobile data terminals (MDTs),
- Smart cards, and
- Advanced passenger information systems.

What special transit needs (markets) exist in rural and small urban areas?

Some of the larger transit system operators who have successfully applied APTS technologies report improved operations, better passenger service, and positive staff attitudes. Yet, transit managers of smaller systems and their local supervisory boards often perceive APTS as too complex and expensive to be appropriate for them. A TRB research project will help identify these issues (TCRP, 1997: http://www2.nas.edu/trbcrp/443a.html).

In order to justify the use of APTS technologies, transit managers must appropriately match them to specific local needs. To do this, consider the local user needs associated with five distinct rural and small urban markets (Boenau, 1997). These markets, in turn, help define special transit service characteristics that can be used to match with appropriate APTS technology (Laster, 1997; James, 1996). Table 1.2.1 summarizes these markets, and the following paragraphs briefly describe the markets and applicable APTS technology.

High Growth, Self Contained Communities

This market needs coordination of transportation providers, accommodation of multiple trip purposes and service enhancements to attract discretionary trips. Quality of service is especially important in high-growth areas. Potential APTS applications include computer-aided dispatch, automated traveler information systems, automated passenger counting and others. Automated CADS software is considered to be the most appropriate software for this market. Self contained, high growth communities have many opportunities to implement new technologies.

Slow/No Growth, Self Contained Communities

Typical transit needs include coordination of human service providers, automation of scheduling and routing, and better record keeping and billing. Potential APTS applications include communication links to enhance flexibility and smart cards to aid in multiple agency billing. Automated and semi-automated software will be appropriate for this service. Self-contained no/slow-growth communities hesitate to use new approaches because new ideas are not readily accepted in a stagnant community, often exhibit a fear of change, and have a strong desire for things to be the same.

Rural to Metropolitan Commutes

Transit needs include interconnection to urban transit systems, utilization of vehicles during non-rush hours, high service reliability, and avoiding traffic delays. Because of job schedules, professional commitments, personal shopping, and human service appointments, transit managers should provide seamless, frequent, and high quality services. Potential APTS applications are automated rideshare matching and dynamic vehicle routing. Automated software is applicable for these systems. In this market segment funding lags growth, so there is usually little or no investment in new technologies.

Table 1.2.1: Rural and Small Town Transit Markets

Rural and Small Town Transit Markets	Market Characteristics	Examples
High Growth, Self-Contained Communities	- Service employment and retirement communities - Economically prosperous, higher percent of work trips - Competition with autos for riders	- Flagler County, FL - Blacksburg, VA - Cherokee County, GA
Slow or No Growth, Self Contained Communities	- aging population - declining population - stagnant economy - high unemployment - high demand for human services - few transportation options - many transit dependent riders	- Towns in Appalachia - Native American reservations - "Rust Belt" towns - Towns in the Great Plains - Towns in the Deep South
Rural to Metropolitan Commuting Areas	- long distance commutes through rural areas - from dispersed to concentrated origins or destinations - bedroom communities with strong metropolitan links and opportunities for high trip volumes.	- Laredo, TX (a growing city in a large distressed county) - Front Royal, VA (home for DC-area employees)
Large Sparsely-Populated Rural Areas	- low population density - low trip volume/demand, - long trip distances.	- Federal Lands - Sweetwater County, WY - Malheur County, OR
Rural Tourist Areas	- large seasonal variation of demand, - congestion during peak tourist seasons, - small service providers.	- National Parks (Yosemite, Grand Canyon, etc.) - Ski and sea resorts (Tahoe, Vale, Cape Cod, etc.)

Sources: Casey, 1996; Boenau, 1997

Large Sparsely-Populated Rural Areas

In this transit market management creativity is an important component of providing transportation. These areas need reliable communication links, coordination of distant service providers, emergency notification and response. Automated vehicle location, emergency communication and smart cards to aid agency billing are considered to be the most useful potential APTS applications. Automated is the most appropriate software for these areas.

Rural Tourist Areas

The needs are utilization of capital equipment, accommodation of tourists and employees, informing customers generally unfamiliar with service, and others. Potential APTS applications are traveler information systems, automated public address systems. Both automated and semi-automated CADS software are applicable for these areas. In rural tourist areas, users must be able to obtain good information quickly and easily, therefore systems must be user-friendly.

What local issues need attention to prepare for APTS?

The previous paragraphs matched market types and APTS options. Next, the discussion will more closely focus on specific local issues to address before final selection of APTS technology.

Transit Management

According to interviews with transit operators and a variety of professional experiences, there are three fundamental requirements for APTS implementation:

- Good management,
- Good training, and
- Competent staff with technical experience.

Together these three requirements build a firm foundation for APTS. Until these three factors are present, an operator should not implement APTS technology. Making a choice about the most appropriate APTS technology for their system requires all three factors and may be one of the hardest assessments a transit operator has to make. APTS cannot overcome deficiencies in these areas.

Furthermore, transit managers in small urban and rural transit systems face challenges that may not be faced by large system managers. These challenges contribute to the slow pace of APTS technology implementation and include the following:

- Questions from the transit board about the utility of APTS,
- Insufficient funding,
- Relative inexperience with technology,
- Institutional constraints.

Transit Operations

Operations for small urban and rural systems also provide specific issues for concern when APTS is being considered.

- Increasing ridership and requests for special service,
- Diverse nature of rural operations,
- Long term habits in scheduling and dispatch dispatch,
- Lack of uniformity in dispatching,

- Limited training opportunities,
- Lack of knowledge in computer and other complementary technologies in APTS,
- Technical support and maintenance.

1.4 Section Summary

The premise of this report is that improved passenger service and system productivity can be mutually accomplished by appropriate application of Advanced Public Transportation Systems (APTS) technology. It is assumed that managers of small urban and rural transit systems are looking for (or should be looking for) advanced technologies to make significant system and service gains. Whether an operator acquires a new technology or is involved in updating the present one, he or she often faces pitfalls, many of which can be avoided with information on available technologies and their compatibility with local transit markets and needs.

To help managers with their choices this report provides technical information, resources and examples of successful APTS procurement. This section of the report in particular presents information on the following:

- Problems that small urban and rural transit managers face as they seek to apply APTS to their services.
- Decision issues relevant to APTS hardware and software selections.
- Appropriate technology choices for small urban and rural transit managers considering such factors as the local transit market, types of passenger trips, size of the transit fleet, and staff capabilities.

The next section of the report will review the state-of-the-art of APTS and emerging technologies.

Section 2
Technology Review

2.1 Introduction

Section 1 of this report described the challenge of meeting transit passenger needs in a variety of small urban and rural settings while improving system productivity. The discussion provided broad categories of advanced technologies to help transit operators meet their operational goals, and it identified some of the problems of making the right choice of technology.

This section of the report begins with the cost savings rationale for using advanced public transportation systems (APTS). Several success stories illustrate the rationale. The remainder if this section addresses technology. First, the discussion presents a broad plan for implementing APTS technology and integrating it with transit operations and passenger needs. Next, the discussion organizes passenger travel options and transit functions within the APTS architecture as a way of organizing technology options. Next, come technology compatibility and standards issues. Operators must choose APTS options that are compatible by way of standards in order to develop a flexible APTS system that is expandable over time with products from different vendors. The section ends with a detailed discussion of scheduling and dispatching software (the "brain" of an APTS system for demand responsive transit) and complementary hardware options.

2.2 The Rationale for APTS Technology: Service and Productivity Improvements

Both small urban and rural transit systems are using APTS technologies with success. Some transit systems have achieved significant benefits in the quality of passenger service and transit operational efficiency. Communities have also experienced broader societal benefits beyond those experienced by just the passengers and transit operators. For example, improved transit mobility enables people to more effectively participate in the government, administration, business and recreation offered by a community. Improved transit services reduce the cost and environmental impact of private automobile use. Improved mobility and service also encourage new economic development as workers' access to jobs improves. These impacts are examples of what can occur at the broader community level (http://www.ctaa.org/dollarsandsense.htm). More specific examples of the benefits at the passenger and transit operations level are presented in subsequent paragraphs.

Small Urban Areas

The Winston-Salem Transit Authority (WSTA) in Winston-Salem, NC, operates Trans-AID, a fleet of 19 small buses in town and the surrounding Forsyth County. WSTA is a case study example of a small urban system that has improved its system productivity and passenger service by using APTS technologies. WSTA primarily serves the sponsored elderly and handicapped clients of human service agencies. Over an evaluation period of 12 months following installation of computer-aided dispatch and scheduling software, WSTA demonstrated that APTS improves daily operations. Based on before and after data, CADS decreased WSTA operating costs 2.4 % per passenger, 8.5 % per vehicle-mile, and 8.6 % per vehicle-hour (Stone, 1996). As a result of increased productivity and dispatcher knowledge of real-time vehicle capacity, WSTA management expanded rural service without acquiring additional vehicles or a new communication system. WSTA estimates a payback period of approximately 16 months on the $100,000 capital investment for the software and related computer systems. WSTA staff, bus drivers and passengers report a high degree of satisfaction with the computer-aided dispatch and scheduling software. They look forward to expanding APTS technology in 1999 including digital mobile data communications, automatic vehicle location, smart cards, and computer-based passenger information systems.

FARETRANS in Ventura County, California installed a smart card system in because of problems with fare evasions and transfers. FARETRANS management estimates that their smart card system will save $9.5 million per year in reduced fare evasion; $5 million in reduced data collection costs; and $990 thousand by eliminating transfer slips (FTA, 1995, www.fta.dot.gov/ntl/index.html).

Rural Areas

Sweetwater County in Wyoming with its 41,000 residents operates a fleet of 19 small buses for a system cost of approximately $245,000 (Table 2.2.2). Rides Unlimited provided semi-automated scheduling and dispatching software to Sweetwater Transit Authority. Ridership increased from 5,000 passengers per month to almost 9,000 passengers per month without increasing additional dispatch staff. Computer aided dispatching allowed same day ride requests to be accepted, increasing demand by 14 percent over the former 24-hour advance notice requirement. Cost per passenger trip (excluding capital and depreciation) decreased from $8.36 in 1989 to $4.22 at the end of 1994. The mobility provided to County residents has allowed individuals to stay out of nursing homes, and it has taken able-bodied as well as disabled people to jobs and training and removed them from public welfare rolls. This has resulted in considerable savings to the County, a portion of which can be attributed to the additional ridership permitted by the computer assisted dispatching system. When Senior Center transportation is taken over, there will be considerable savings to the Center from a reduction in the cost per trip, drug testing of transportation personnel, and insurance (Casey, 1997). Recent APTS deployment includes a GPS based AVL system and MDTs. AVL will allow dispatcher to monitor vehicle when system is expanded. MDTs allow the dispatcher to leave messages with the operator when they are not in the vehicle, and reduce radio airtime. Third phase is to coordinate AVL deployment with Sweetwater police.

The Boone County Transportation System in Iowa is a small, rural paratransit agency with approximately 15 vehicles generating 16,000 bus hours annually. It serves 350 rides per day. The Boone County Transportation System management decided to contract for CADS with an automatic vehicle location system (AVL)(Table 2.2.2). Management commissioned a cost-benefit analysis of AVL with dynamic scheduling to determine if implementation was justified. The costs included purchase, implementation and training. Assuming a "conservative" 5% improvement in vehicle utilization and ridership and an "optimistic" 10% operations improvement, the analysis yielded the results in Table 2.2.1.

Other Small Urban and Rural Examples

Cost-benefit information for APTS technologies in small urban and rural areas is scarce. Table 2.2.2 summarizes available information. Besides the scarcity of empirical evidence, what information that is available poorly represents the wide variety of operating scenarios and transit markets for small urban and rural areas (Section 1.3, Table 1.2.1). Furthermore, the available data suffers from inconsistent evaluation and reporting methods as evidenced by the vacant cells in Table 2.2.2. Section 3 of this report will address these deficiencies and provide a more complete picture of case study APTS implementations including APTS technical support needs, upgrades and training, and APTS evaluation issues.

Table 2.2.1: Boone County APTS Costs and Benefits

Net Present Value of Costs	Net Present Value of Benefits (conservative estimate)	Net Present Value of Benefits (optimistic estimate)
$72,300 (CADS + MDTs)	$125,500	$193,200
$80,000 (AVL only)	$ 89,600	---

Source: Kihl, 1996

Table 2.2.2: Summary APTS Costs and Benefits

Urban/Rural Area	Technology Used	Cost	Savings	Benefit Measurement	Benefit Amount	Source
Boone Co., IW	CADS	$72,300	$193,242	Vehicle & riders Operations	+10% + 5%	Kihl, 1996
Boone Co, IW	AVL	$80,000	$86,598	Vehicle & riders Operations	+10% + 5%	Kihl, 1996
Santa Clara, CA	ATSS, MDT, AVL		$0.49M/yr	Cost/pass. mile	- 2.5%	TRB, 1996
Ventura, CA	SC		$10.5M/yr			CTAA, 1995
Winston Salem, NC	CADS	$100,000		Cost/ pass. trip	- 2.4%	Stone, 1996
Sweetwater Co, WY	CADS	$245,000		Cost/pass. trip	-$4.14	Casey, 1997
Madison Co, IL	CADS, MDT			Pass/hour	+ 0.4	Kihl, 1996
Antioch, CA	CADS			Riders/day	+ 40	Kihl, 1996

Note: "+" indicates increase and "-" indicates decrease.

ATSS Automated Trip Scheduling System
AVL Automatic Vehicle Locator
MDT Mobile Data Terminals
CADS Computer Aided Dispatching System
SC Smart Cards

2.3 APTS Architecture: A Blueprint for Service and Productivity Improvement

National Perspective

A system architecture is simply a description of how devices and sub-systems interact to achieve the goals of the system. According to the "ITS Architecture Executive Summary" (USDOT, 1997) a system architecture defines:

- Complete system operation,
- Function of each device, component or sub-systems.
- Information flows among device, components or sub-systems.

The Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA) gave USDOT the responsibility to provide the leadership and guidance necessary to ensure national ITS compatibility over the long term. The compatibility relies upon establishing a unifying national ITS architecture. According to the USDOT ITS Joint Program Office, the national ITS architecture provides a master blueprint for building an integrated, multimodal, intelligent transportation system. ITS architecture defines the framework around which a generally common ITS infrastructure can be developed at the national level, while ensuring that local needs are met. This will help state and local decision-makers plan smarter and buy smarter, ultimately saving time and money in the future.

The national ITS architecture gives guidance on the broad range of transportation functions and information flows. By framing these information flows, the national ITS architecture also serves as a tool that provides stakeholders with an understanding of the entire transportation network and how various service providers can work together. It serves as a focal point for agency officials to consider new ways of enhancing the existing physical infrastructure to provide the most efficient transportation system possible. Officials concerned with metropolitan, small urban and rural intelligent transportation systems will all benefit from using the national ITS architecture. It defines complete system operation, what each component does, and what information is passed between components.

The APTS architecture is a subset of the national ITS architecture and serves the same planning, design and operations functions for transit as the national architecture does for other forms of ITS (Sandia Labs, 1994). As Figure 2.3.1 illustrates a transit manager who is planning for APTS should consider local transit passengers and markets (Section 1.3) and the operational requirements for vehicles, drivers, staff and management. In other words, a transit manager should consider the overall transit system. Next, the transit manager should consult the national APTS architecture for the communications links and other functions of APTS technology. The national architecture suggests worthy technical solutions that can be adapted to fit local problems. Before selecting actual APTS components and designing an APTS system for local application, certain technical standards must be met by the APTS components in order to assure compatibility and the flexibility for future upgrades. According to Figure 2.3.1, if these steps are followed, a specialized APTS system for local problems can be deployed. A summary checklist for APTS selection, procurement and implementation is given in Section 5 of this report. Additional information can be obtained from "ITS Development Guidance for Transit Systems (USDOT JPO, 1997).

Local Perspective

Figure 2.3.2 illustrates an APTS architecture for which the transit operations center is the hub of local information flow between transit users and transportation providers. This centralized architecture represents the "mobility manager" concept that became popular in the early 1990's. As shown by Figure 2.3.2, passengers communicate directly with the transit operations center that dispatches the appropriate provider – bus, rideshare, taxi, or demand responsive service.

Individuals can arrange transportation service by contacting a transit service center by telephone, kiosk, cable TV, or other communication methods. All passenger fare taking, billing and record keeping are handled by the transit operations center, as well as transit system functions necessary to keep the fleet productive.

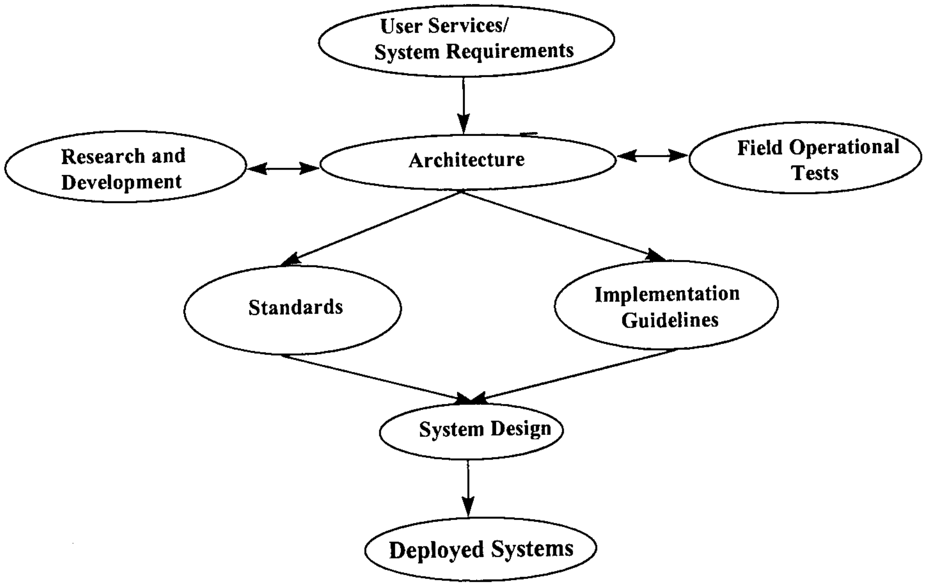


Figure 2.3.1: APTS Implementation Process (IVHS Architure Bulletin 1994)

New personalized communication by cell phones, pagers and palm-size email/Internet devices are supporting emerging, decentralized architectures. The architecture appears much like that of Figure 2.3.2 except that the role of the transit operations center is greatly reduced as a hub of information flow between passenger and driver. Basically the "middle man" function of the mobility manager is eliminated. Typical dispatching and scheduling functions are accomplished on-board the vehicles through a distributed computer network. The transit operations center focuses on the vehicle side of the system – fleet status, passenger and vehicle data collection, public information, planning, personnel and management. In either the centralized or the emerging decentralized architecture, the major role of APTS technology is to facilitate communication between the passenger and the transportation provider.

Figures 2.3.3 and 2.3.4 show how APTS technology serves other important functions besides passenger-vehicle matching. Those functions include incident reporting to improve safety, vehicle coordination to improve schedule and transfer adherence, vehicle status monitoring for safety and maintenance, administrative reporting of passenger and vehicle information, road conditions, collision avoidance, driver impairment alert, traffic signal coordination, etc. These are the types of functions that would likely remain in the domain of the transit operations center under the decentralized APTS architecture.

In summary, a transit system architecture helps assure achievement of passenger service and transit productivity, guides correct component specification for sensible APTS deployment, fosters technology markets and ensures equipment compatibility and interoperability. The APTS architecture gives a broad blueprint of transit planning and development, project definition, project approval, funds identification and allocation, design, project management and implementation, operations and technology support.

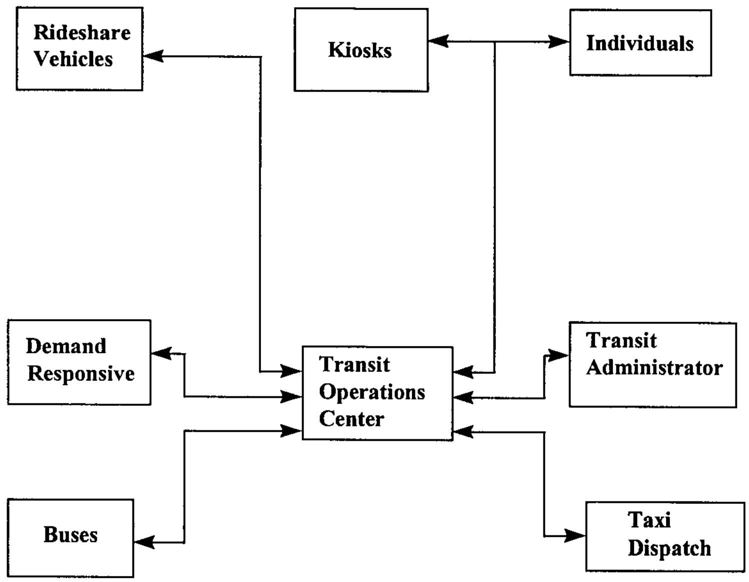


Figure 2.3.2: APTS Information Flow (Centralized Architecture)

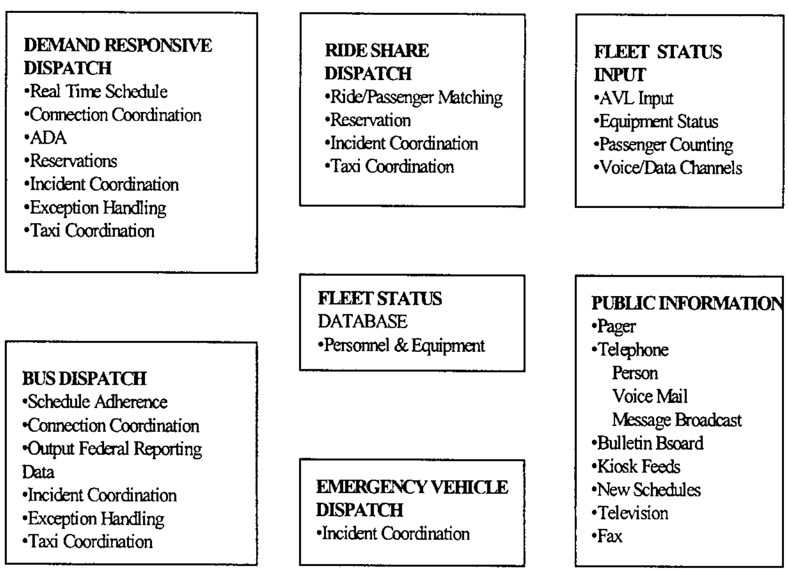


Figure 2.3.3: Architecture for a Transit Operations Center

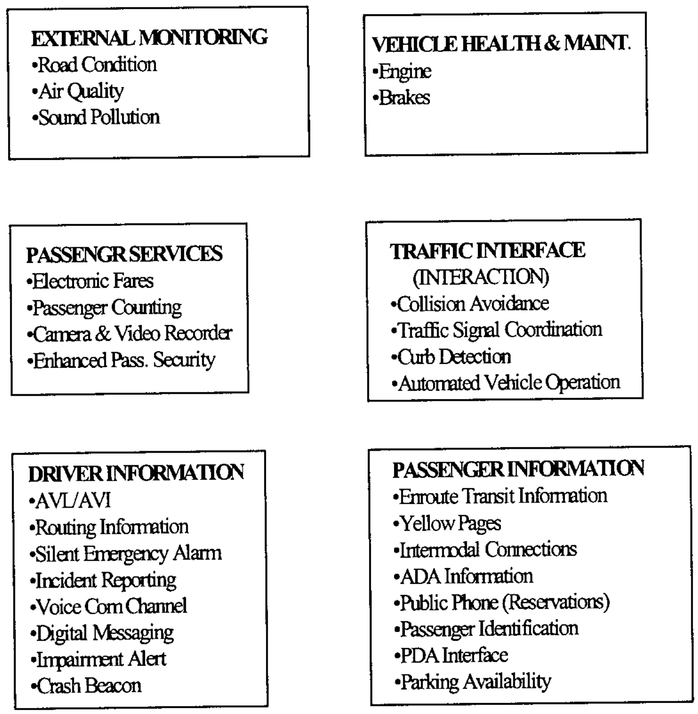


Figure 2.3.4: Architecture for Demand Responsive Vehicles

2.4 APTS Technology Standards

As shown by Figure 2.3.1 the APTS implementation process requires transit operators to deploy APTS technologies according to communications standards. Standards are non-proprietary and guarantee an open architecture that allows modular design of APTS sub-systems. By choosing appropriate APTS technologies that meet industry communications standards for interoperability, transit managers can use different vendors' components with less concern about incompatibility. Having communications standards is also extremely important to APTS developers, consultants and agency officials. Such standards throughout a state and across the nation, as well as at a local transit agency, simplify research, development, marketing, procurement, training, operations and maintenance. As discussed below, several transit standards development activities are underway and will produce recommendations in mid-1998.

Vehicle Area Network (VAN) Standard

The VAN standard consolidates several existing standards for transit vehicle sub-systems. Society of Automobile Engineers standard J1708 defines transmission, drive train, hardware and communications formats. SAE J1587 defines protocols and SAE J1455 defines environmental requirements. By the end of 1998 a new SAE standard will define cable and connector designs.

As a result of the SAE standards transit properties can specify and procure an electronic device for a vehicle from any vendor and expect that it will work on any vehicle and communicate with other vehicle devices and subsystems (APTS Update, USDOT, 1998). Manufacturers can market devices purely on performance and cost, and not worry about compatibility or custom installations. Agencies can functionally specify their procurements, and they can upgrade modules, instead of discarding previous sub-systems. VAN standards for communications and hardware interfaces guarantee that on-vehicle sub-systems will work on any VAN-based transit vehicle.

Transit Communications Interface Protocol (TCIP)

TCIP is another major standard (www.tcip.org). TCIP will define the data interface structures that will allow different transit components to exchange data, and allow data exchange between the vehicles and transit operations center, and the operations center and external agencies like traffic management centers. TCIP profiles act as a extended layer between existing interfaces or between proprietary systems. If two sub-systems are TCIP compatible, then they can communicate with each other. Sub-systems include fare collection, incident management, onboard/control center communication, passenger information, scheduling and runcutting, spatial representation, and traffic management.

While considering hardware and software for a system, one of the main goals is to select interoperable technologies. Some of the major characteristics that are considered by transit operators are compatibility, upgradability, plug-and-play capabilities, and others. TCIP will allow such interoperability and provide the antidote to the apprehension attendant in transit system implementation (TCIP, 1997, www.tcip.org/paper2.html).

2.5 Operating Systems

Besides choosing APTS technologies that have compatible communications standards, transit managers must purchase computers and software that are compatible. Basically the choice is one of computer operating system. An operating system is a special program that manages programs and data files. It also controls the computer components such as keyboard, screen, disk drives, modem, printer and other peripherals that interface with the user.

Since 1996 most computer users have chosen Windows 95 and Windows NT 4.0 operating systems. The choice can be related to the ubiquity of programs that run on Windows 95 and NT, their low cost, and user friendliness. Windows 95 and NT allow full 32 bit applications and multitasking, and it is "plug and play" compatible with many peripheral devices as a result of having computer-based standards. Other operating systems include DOS, which Windows 95 and NT have replaced UNIX and Apple Macintosh. UNIX may be used in special applications. Almost no one is using Macintosh products in transit applications.

During the period that Microsoft Corporation introduced Windows 95 and NT 4.0 there was a great expansion in the use and utility of the Internet. While the Internet is not an operating system per se, it is emerging as the computer interface between many users and their professional functions. As it continues to mature with many providers and features, it will develop many of the same issues that operating systems have in the past. More and more the Internet will be the pipeline for information into and out of the transit agency, if not actually within the agency. Thus, the Internet deserves attention as a type of operating system.

2.6 Vendor Survey

A literature review and a vendor survey conducted during this project provide the information on APTS technology that follows in subsequent paragraphs. The vendor survey concentrated on the functionalities, computer requirements, compatibility, costs, training, etc.

The literature review identified the names of companies that implement their products in small urban and rural public transportation operations. Then these vendors and others received the survey (Appendix B) by fax or mail. 89 vendors received the survey and about 30% responded (Table 2.6.1).

Table 2.6.1: Vendor Survey Summary

Product Type	Surveys Mailed/Faxed	Surveys Returned	Response Rate
CADS	60	16	27%
AVL	11	6	54%
MDTs	6	3	50%
Electronic Fare Cards	9	2	22%
Total	86	27	31%

Some observations from the survey responses include:

- Vendors with larger market shares were more likely to respond to surveys.
- Operating system choice has migrated to Windows 95 and Windows NT from UNIX, DOS, and Windows 3.11.
- Most products export to ASCII or dBase formats.
- On-site training is included in product cost for most products. Travel and sustenance for trainers are not included in price.

More detailed survey information follows below. Summary tables appear at the end of the chapter.

2.7 Scheduling and Dispatching Software

Dispatching and scheduling apply to demand responsive transit services.Trip scheduling is the process of inserting a passenger trip request into an actual or provisional schedule so that no system, operations, or passenger constraint is violated. Dispatching is the process of assigning an actual vehicle to a passenger trip and communicating that assignment to the driver of the vehicle. The dispatching assignment tells the driver when and where to pick up and to drop off the passenger. Because passenger transportation is the fundamental service provided by transit, scheduling and dispatching software is considered to be fundamental to successful operations. As displayed by Figure 2.7.1 it is evident that scheduling and dispatching software operates when there is an interaction between the passenger, the call taker in the transit operations center, and vehicle driver.

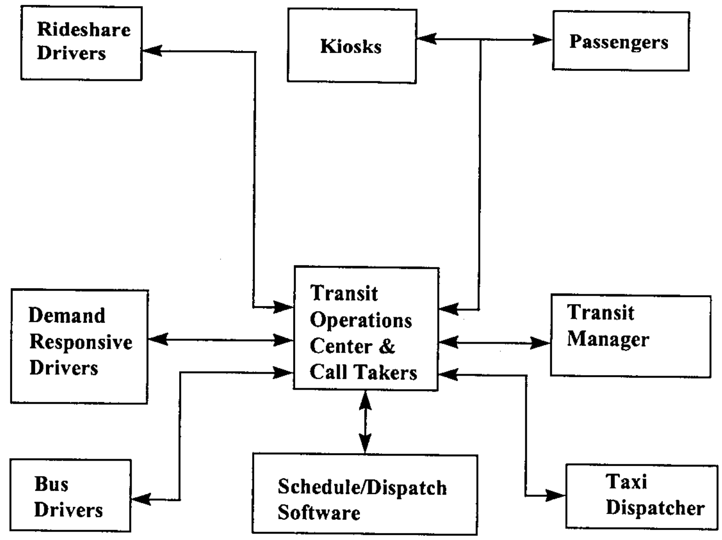


Figure 2.7.1: APTS Information Flow (Centralized Architecture)

While some small transit systems still use **manual scheduling and dispatching techniques** complete with large wall-mounted vehicle schedule boards, most transit systems have converted to some form of computer-aided scheduling and dispatching. For convenience of discussion computer-aided software has four levels:

- Off-the-shelf software,
- Custom database software,
- Semi-automated CADS software,
- Fully-automated CADS software.

Depending on the type of scheduling and dispatch software there are various characteristics, functionalities, computer requirements, and degrees of compatibility with APTS hardware. Experienced transit operators who use scheduling and dispatch software have ranked the desirable characteristics as shown by Table 2.7.1 (Lave 1996). The table illustrates the range of sophistication of the different types of scheduling software and a distinct preference for the capabilities offered by fully automated software. To some extent the rankings represent a "wish list" of functionalities assuming that the transit system size and passenger demand warrant the more sophisticated and expensive software and that the staff can manage the new technology. The range suggests that a graceful upgrade approach may be available if the package is chosen carefully and that only the latest and fastest model computers should be used for whatever application is used.

Table 2.7.1: Priority Software Functionalities

Rank	Functionalities	Level 1	Level 2	Level 3	level 4
1	Fully computerized scheduling and dispatching				
2	Trip eligibility check (for ADA trips)				
3	Vehicle location on layered maps				
4	Allows "what if" questions				
5	Simulation training capability				
6	Choice of performance criteria (ride/wait times, etc.)				
7	Trips displayed on layered maps				
8	On-line time (pickup, etc.) estimates				
9	Redundant reservation warning				
10	Problem passenger warning				
11	Pop-up menus/multiple windows				
12	Performance data calculations				
13	Variable vehicle parameters (Number, seating, etc.)				
14	Automatic rider eligibility check				
15	Personalized passenger loading times				
16	Validity checks on all inputs (completeness, legitimacy, etc.)				
17	Geocoded addresses				
18	Manual override of computer generated schedule				
19	Computerized vehicle route selection				
20	Flagging of costly trips				
21	Import/export to spreadsheet				
22	Automatic purge of inactive registrants				
23	Automatic vehicle selection for passenger special needs				
24	On line address verification				
25	Frequent destination list				
26	Immediate (real-time, like taxis) reservations & scheduling				
27	Automatic call-back confirmation and change of schedule				
28	On-line "help" available				
29	Automatic in-vehicle data capture				
30	Keyword search and sort capability				
31	Tracks recent ride history				
32	Name recognition of common places				
33	Batch scheduling / dispatching				
34	Partial name/address entry				
35	Support for brokering (several operators)				
36	Vehicle speed is a function of traffic, time, geography				
37	Call-back list generated				
38	Automatic retrieval of passenger data				
39	Import/export to word processor				
40	Ad hoc report formats				
41	Section 15 reports				
42	Multi-user reservation processing				

Table 2.7.1 continued

Rank	Functionalities	Level 1	Level 2	Level 3	level 4
43	Paratransit transfers				
44	User-defined fields available				
45	User name & date stamping				
46	Remote terminal access				
47	Passenger prioritization possible				
48	Fixed route transfers				
49	Automatic fare calculation				
50	Multi-tiered security				
51	Import/export ASCII files				
52	Zonal system				
53	Group trips				
54	Flexible invoice formats				
55	TIGER file compatibility				
56	Split billing				
57	Electronic Document Interchange				
58	Federal HHS report				
59	Batch billing				
60	Billing codes				

Software Level Definitions:

1 = Off-the-shelf software (word processing, spreadsheets, database programs)
2 = Custom database applications (off-the-shelf software modified by a local programmer)
3 = Semi-automated programs (commercial products for zone-to-zone transit operations)
4 = Fully automated programs (commercial products with scheduling/dispatch, APTS functionalities)

Tables 2.7.1 and 2.7.2 summarize the four software levels or categories that are described in detail in this section. Table 2.7.1 ranks functionalities by software level (category), and Table 2.7.2 includes for each software category its characteristics, ranked functionalities, computer requirements and APTS compatibility.

Table 2.7.2: Scheduling and Dispatching Software "Levels", Functionalities and APTS Compatibility

Software Levels	Software Level Identifiers	Priority Functionalities & Capabilities	Rank	Computer Requirements	APTS Compatibility
Automated	Contains all characteristics of Semi-Automated s/w plus -able to generate full schedule and dispatch arrangement without human intervention -manual override of computer generated schedule -uses GIS system to geocode addresses of origins and destinations in order to automatically schedule a passenger on a specific vehicle -some packages may be linked to MDT's, AVL, and other odometer readers in order to further automate dispatching and record keeping	-fully computerized scheduling and dispatching -trip eligibility check -vehicle location on layered maps -allows "what if" questions -simulation training capability	1 2 3 4 5	-Pentium class	Compatible with most APTS technologies. For example: AVL,MDT, Smart Cards etc.
Semi-Automated	Contains all characteristics of Custom Database s/w plus -database application written for use by many transportation systems which allows zone-based trip scheduling	-pop-up menus/multiple windows -automatic in-vehicle data capture -tracks recent ride history -support for brokering -remote terminal access	11 29 31 35 46	-Pentium class	Limited
Custom Database Application	Contains all characteristics of Off-the-Shelf s/w plus -includes table for trip request -database application written by local programmer for transportation system which does not allow zone based trip scheduling	-redundant reservation warning -performance data calculation -variable vehicle parameters -validity checks on all inputs -flagging of costly trips	9 12 13 16 20	-Pentium class	Custom applications
Off-the-Shelf	-the database or spreadsheets are setup by non-programmer transportation system staff -a table for client list is usually included -there may be table(s) for vehicle manifests -billing information may be entered on tables by hand after performance of trips	-problem passenger warning -automatic rider eligibility check -import/export to spreadsheet -keyword search and sort capability -import/export to word processor	10 14 21 30 39	-Pentium class	Not Compatible

The ranked functionalities are the top five functionalities/capabilities desired by a panel of transit managers for future software procurements. Any level of software inherits all the functionalities of lower levels. (Lave 1996)

Off-the-shelf software has no pre-programmed scheduling and dispatching functionality. Local transit staff apply standard spreadsheet and database programs such as Excel, Access, FoxPro or others to meet their needs. Such programs may come "bundled for free" with a new computer purchase. Hence, they can be inexpensive. Staff members can program original applications or they can run useful "templates" supplied by state agencies or other transit operators. The following information summarizes off-the-shelf-software.

Characteristics:
- These database or spreadsheets are setup by non-programmer transportation system staff.
- A table for the client list is usually included.
- There may be tables for vehicle manifests.
- Billing information is entered by hand after trips are performed.

Operating Systems:
- Older 486 computers: Windows 3.11
- Newer Pentium computers: Windows 95/97, Windows NT

Price:
- $100 to $500 per program unless "bundled" with a computer purchase
- "Free" programming by staff
- Free programs and files from RTAP or state support office

System size:
- Generally fewer than 10 vehicles, sometimes more
- Less than 200 subscription trips a day

Vendors:
- Microsoft, FoxPro, IBM and others

Compatibility:
- Off-the-shelf software is not compatible with AVL, MDTs, smart cards, etc.

Custom database applications use generic spreadsheet or database programs customized to fit a demand responsive transit operation. Usually the transit agency hires a programming consultant to develop the scheduling package.

Characteristics:
- All the characteristics of off-the-shelf software
- Passenger database including address, phone number, typical destinations, etc.
- Table for trip requests
- Does not allow zone based trip scheduling
- May include record keeping and billing functions

Operating Systems:
- Older 486 computers: Windows 3.11

- Newer Pentium computers: Windows 95/97, Windows NT

Price:

- $1,000 to $10,000

System size:

- 10-30 vehicles
- Less than 500 daily subscription trips and less then 150 daily demand responsive

Vendors:

- Same commercial software companies as for off-the-shelf
- Computer programmers and consultants for local development

Hardware Compatibility:

- Incompatible with APTS hardware without special adaptations

Semi-automated CADS software has the capabilities of custom database applications, plus the software may be able to perform zone-based scheduling. These products may have APTS hardware compatibility for additional functionality. There are three types of semi-automated software products:

- slot schedulers,
- schedule-assist, and
- fully-automated "capable" software.

Slot-schedule products (such as Trip Management System) are not capable of automatically placing passenger trips on vehicles. They simply keep track of the vehicle on which the scheduler has placed a particular passenger. Schedule-assist products (such as CTS, Dispatch-a-Ride, and Mini-Pass) have the capacity to suggest vehicles on which to place riders. They accomplish this function by defining zones in the service area and listing the street address ranges within that zone. Schedule-assist products have a database of intra-zonal and inter-zonal travel times and use this information to suggest vehicle assignments. Some schedule-assist products (Mini-PASS, Cadmos Pro and Transnet) are fully automated "capable". This means that for an optional price, the vendor will upgrade them to fully-automated software by attaching additional program modules and a GIS map for geocoding trip origins and destinations.

Table 2.7.3a summarizes important information about semi-automated CADS software. The scheduling products use a variety of operating systems (Windows NT is becoming preferred), apply to systems with typically a variety of sizes, and obtain compatibility by exporting data files to conventional ASCII or dbase formats. Relatively few products are compatible with APTS hardware. Table 2.7.3b gives typical software and training costs.

Table 2.7.3a: Semi Automated CADS Vendors

General Information							
Company Name	**Product Name**	**Operating System**	**Suggested # of Vehicles**	**Transit Installations**	**Date of First Installation**	**Interfaces with**	**Exports To**
Advanced Transit Solutions 800/640-5844	Schedule Manager	DOS/W3.11 W95 WNT3.51 WNT4.2	1-100	3	1997		All
Computer Technology Int'l 404-320-7003	SCOOTER	DOS/W3.11 W95 UNIX	21-49	15	1983		ASCII
CTS Software, Inc. 800/704-0064	Rural paratransit scheduling and info. mgt. system	DOS/W3.11 W95 WNT3.51 WNT4.2	1+	100	1987		dBase ASCII
Decision Science, Inc. (DSI) 847/864-0919	Quick Route	DOS/W3.11	1+	2	1978	MDT	DBASE
Henson Consulting 540/546-2530	Trip Management System	DOS/W3.11	1-30	10	1994		DBASE ASCII
Micro Dynamics Corporation	CADMOS Pro +	W3.11 Novel 3.12	50+	1	1990	MDT, Pagers	All
Micro Dynamics Corporation	Dr. Dispatch	W3.11 Novel 3.12	5+	7	1990	MDT	All
Multisystems, Inc. 617/864-5810	DISPATCH-A-RIDE	UNIX	1-10	25	1985		ASCII, lotus excel
PC Solutions, Inc. 704/525-9330	TransNet TransNet Mobile	DOS/W 3.11 W 95	1+	1	1996		ASCII Palm Pilot
Management Analysts, Inc. 904/441-4621	Rides Newrides	DOS DOS/W95 WNT	1-150 1-150	1 1	1984 1997	AVL, MDT, mapping, radio, card reader	All
Trapeze Software Group 602/627-8400	Mini PASS	DOS/W3.11 W95 WNT3.51 WNT4.2	1-30	23	1996	AVL, MDT, Smart Card	All

Table 2.7.3b: Semi-Automated CADS Vendors

Training and Cost Information						
Company Name	**Product Name**	**Initial Training Period**	**Initial Training Cost**	**Additional Training Cost / Day**	**Software Cost**	**Annual Software Maintenance Fee**
Advanced Transit Solutions	Schedule Manager	1 day	$3,500+ Travel *	DNR	$4,995+	10% of Cost
Computer Technology International	SCOOTER	1-2 days	$750 – $1500	$750	$1,795 +	10% of Cost
CTS Software, Inc.	Rural paratransit scheduling and info. mgt. System	As needed	Included	Included	$14,500	$3,600
Decision Science, Inc. (D.S.I)	Quick Route	3	Included	$700	$9,000- $22,000	15% of cost
Henson Consulting	Trip Management System	0-1 day	$700	$700	$249/DOS $349/Windows	None
Micro Dynamics Corporation	CADMOS Pro +	0-3 days	Up to $995	$360-$520	$4,995	$540 1 time fee
Micro Dynamics Corporation	Dr. Dispatch	0-3 days	Up to $995	$360-$520	$1.295	$540 1 time fee
Multisystems, Inc.	DISPATCH-A-RIDE	0-3 days	Up to $1,600	$800	$9,500	$1,800
PC Solutions, Inc.	Transnet TransNet Mobile	2 days	$750/day Travel	$675	$4,900 $7,500 +	$250
Management Analysts, Inc.	Rides Newrides	1 week 1 week	Included Included	$200-300 Travel	Rides $14,000 NewRides $17,500	$100 per month
Trapeze Software Group	Mini PASS	5-6 days	Included	$880	$10,000 – $30,000	20% of license fees

* Not at transit system

Fully automated software geocodes trip origins and destinations with x and y coordinates rather than assign the locations to geographic zones. With its high level of technical sophistication fully automated software generates the full schedule and dispatch arrangement without human intervention. However, the staff scheduler or dispatcher may modify or override the automatically determined schedule/dispatch assignment. Each time a trip is to be added or taken out of an existing schedule, a vehicle is reported late, or there is a cancellation, all trips can be rescheduled automatically or upon dispatcher command. Fully automated software is compatible with APTS hardware or can be customized. Indeed, for the scheduling and dispatching to be fully automated without staff intervention an AVL system would have to track the vehicle and communicate to the control center via the MDT. Furthermore, as passengers board and deboard a smart card reader would have to keep track of vehicle stops and individual passenger trip itineraries. This level of automation has not been obtained except in experimental demonstrations.

Table 2.7.4a summarizes important information about fully automated scheduling software. Compared to semi-automated products, fully automated are compatible with more hardware devices. Table 2.7.4b gives software and training costs.

2.8 Complementary Hardware

Hardware devices may be defined as the physical components of a system. Examples for advanced transportation systems applications include mobile data terminals (MDT), automatic vehicle locators (AVL), advanced fare collection technology, automatic annunciators, automatic passenger counting systems, real time passenger information systems, and other emerging technologies. Applicability of each of these technologies depends on the needs of the transit system, availability of resources, technical background of the transit staff, and compatibility of individual hardware devices with other devices and with scheduling software.

The choice of hardware can be tricky and expensive. The benefit of using complementary hardware in a system should exceed the cost of the equipment, installation cost, and cost of communication interfaces. The decision whether to buy a certain hardware for a system depends on various factors. One factor is the amount of information to transfer from the central dispatch section to the individual vehicle unit. The need for hardware increases with the increase in the amount of information to be transferred. It also increases as the needs for trip validation and billing increase. If the mileage traveled, drop-off time, and pick-up time must be known automatically and with precision, then the use of complementary hardware becomes essential.

The size of a transit system in terms of the number of vehicles and the number of trips per day contribute to the decision for acquiring appropriate hardware. For example, a system with more than 300 demand responsive trips may need a MDT, as well as scheduling and dispatching software. If a substantial portion of the schedule contains real-time, demand responsive trips, then an AVL plus the MDT should be considered. Another important factor to consider is the compatibility of the hardware with the scheduling and dispatching software. Usually only fully automated software products have compatibility with complementary hardware.

Table 2.7.4a: Fully Automated CADS Vendors

General Information							
Company Name	**Product Name**	**Operating System**	**Suggested # of Vehicles**	**Transit Installations**	**Date of First Installation**	**Interfaced with**	**Exports To**
Advanced Transit Solutions 800/640-5844	Schedule Pro	DOS/W3.11 W95 WNT3.51 WNT4.2	1-100	10	1992		All
Computer Technology Intr'l 404/320-7003	SCOOTER w/ Digimaps	DOS/W3.11 W95 UNIX	21-49	7	1983	AVL	ASCII
GIRO, Inc. 514/383-0404	ACESS Reservation System (Paratransit)	UNIX, WNT 3.51, WNT 4.2	50+	7	1985	AVL, MDT, Digital Radio	ASCII etc
IRD Teleride 416/596-1940	TransView	WNT 4	5+	15	1995	AVL, MDT, IVR	All
Multisystems, Inc. 617/864-5820	MIDAS PT	W95, WNT 3.51, WNT 4.2	11+	20	1995	AVL, MDT	All
RouteLogic 954/431-7250	ParaLogic RouteMap ParaRoute	DOS/W3.1, W95, WNT	1-30	5 sites for all products	1197 1995 1998		All, Including GIS products
Trapeze Software Group 602/627-8400	PASS for Windows 95	DOS/W3.11 W95 WNT3.51 WNT4.2	6+	130+	1989	AVL, MDT, Smart Card	All

Table 2.7.4b: Fully Automated CADS Vendors

Training and Cost Information						
Company Name	**Product Name**	**Initial Training Period**	**Initial Training Cost**	**Additional Training Cost / Day**	**Software Cost**	**Annual Software Maintenance Fee**
Advanced Transit Solutions	Schedule Pro	2-3 days	$4,500+ Travel *		$9,995+ *	10% of Cost
Computer Technology International	SCOOTER w/ Digimaps	1-2 days	$750-$1,500	$750	$3,795 + **	10% of Cost
GIRO, Inc.	ACESS Reservation System (Paratransit)	2-3 days	Included	$800	$100,000 - $2,000,000	$10,000- $50,000
IRD Teleride	TransView	5 days	Included	$900 + Travel	$35,000+	$2,500+
Multisystems, Inc.	MIDAS PT	10 days	Included	$800	$50,000 +	$6,000+
RouteLogic	ParaLogic RouteMap ParaRoute	5 days 5 days 5 days	$750/day or $3,000/week	$750/day all products	1 user: $7,995 1 user: $7,995 1 user: $9,995	1 user: $395 2-5 users: $795 6-10 users: $1,195
Trapeze Software Group	PASS for Windows 95	13-20 days	Included	$880	$30,000 – $750,000	20% of Cost

*Not at transit system.
**Includes Maintenance Tracking Software
***Does not include GIS maps or map setup

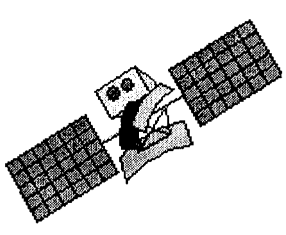
When estimating the total hardware cost, the equipment cost plus the interfacing cost should be added. Custom integration can prove very expensive. For example, under a centralized architecture AVL and MDT systems communicate directly with the dispatch center. The wireless communications systems require vehicle modems, digital radios and a base station with tower, radios, modems and computers. Besides conventional radios, the communications network can be based on cellular or digital telephone service. Thus, the communications network may be purchased and operated "in-house" or leased.

Factors that determine the most appropriate communications for complementary hardware include:

- Available radio frequencies (FCC licenses may be unavailable or require 6 to 12 months to process).
- Bandwidth (the wider the bandwidth frequencies, the more information transmitted)
- Area coverage (depending on tower location, terrain, and radio power the covered area may be restricted and have "shadows" of poor reception).
- Funding (grants may not be available to lease equipment or radio service).

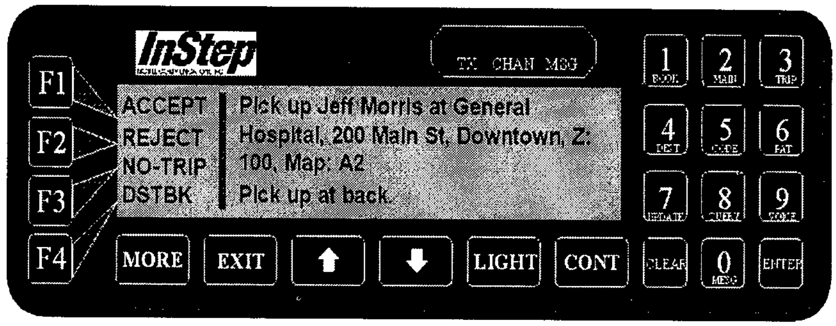
Communications are so complicated for complementary APTS software and hardware that an expert should be on the procurement team.

Automatic Vehicle Locators are an assembly of technologies and equipment that permit centralized and automatic determination, display, and control of the position and movement of multiple vehicles throughout an appropriately instrumented area. Automatic vehicle position and movement determination is accomplished in contemporary AVL systems by a periodic process of inquiry and response, initiated and controlled from what is designated as the central control facility. If information on all trips is available, the automated scheduling software can compute the optimal routes for all the available vehicles. AVL aids the process of real time pick-ups and helps in the optimization of vehicle time and reduces passenger wait time. Safety is also one of the most important features of AVL. AVL can track vehicles in trouble within minutes and can hasten the rescue process. Other benefits of AVL include better on-time performance, schedule adherence, and ADA compliance. According to one report (National Urban Transit Institute 1997) AVL systems pay for themselves when they reduce fleet sizes by 2.3%. The report also indicates that several transit agencies have reported fleet size reductions of 4 to 9%, thus reaping significant savings over AVL investment.



There are three methods of tracking vehicles: LORAN C technology, signpost technology, and global positioning system (GPS). GPS is the clear favorite for transit especially if it operates away from urban centers and on variable routes and schedules. To use GPS a transit system sets up a satellite receiver in each vehicle; the receiver scans the signals from as satellites to get its position and transmits that position to a central location. The GPS receiver mounted on the vehicle locks onto at least three satellites in order to determine its position. Each satellite moves at approximately 3500 meters per second and constantly transmits two types of data - instantaneous position of the satellite and the range data that are used to correct for the change in the position of the satellite. The GPS receiver mounted on the vehicle receives the position and range information from each of the three satellites, then uses mathematical and statistical techniques to calculate its own earth-based location, along with the maximum error in that location. The location is then communicated to a central dispatching station that displays the location on a map.

Table 2.8.1a gives vendor information on AVL systems, and Table 2.8.1b summarizes cost and training information.



Mobile Data Terminals display short written dispatch messages. They replace voice radio communication between the driver and the dispatcher except in emergencies or other exceptional cases. MDT's serve as the communication hub between the vehicle and computers at the control center. They automatically send vehicle location, passenger counts, engine performance, mileage and other information. Some information like passenger boardings and deboarding may be sent when the passengers' "swipe" their smart cards are as they enter or depart the vehicle or when the driver pushes function keys on the MDT. The driver can use other function keys to send pre-recorded digital messages regarding vehicle and passenger status or in response to questions or prompts displayed on the MDT screen. Thus, the MDT can virtually replace note taking and written manifests. It becomes the entry point for data to perform system-wide passenger accounting and vehicle performance analysis. Table 2.8.2 summarizes MDT vendor and cost information.

Smart Cards contain information that can be queried or supplemented by a card reader. The cards have an integrated circuit chip, a central processing unit and an operating system like a small computer. The reader activates the card to identify the passenger, determine the source and amount of fare, or other information. Persons in various consumer situations like in health care, retail, transportation, and travel use smart cards. Table 2.8.3 summarizes smart cards.

Real Time Passenger Information Systems provide information to passengers with the help of various technologies. Some examples are the interactive kiosks that provide real-time schedule information, route planning information, fares, etc.

Automatic Annuciators announce the next stop, transfer point, and other information about the trip. Some are integrated with an AVL system that provides the location cue to the annunciator that then plays a pre-recorded message. There can be both audio and visual announcements that can take the place of the driver having to announce each stop.

Communication Technologies are undergoing rapid change. Fifteen years ago the mobile voice radio was the primary communication tool for transit. In the past five years MDT's have become widely used. In the next few years as the communications spectrum becomes more and more

Table 2.8.1a: AVL Vendors

General Information							
Company Name	**Product Name**	**Operating System**	**Suggested # of Vehicles**	**Transit Installations**	**Date of First Installation**	**Interfaced with**	**Exports To**
3M 612/736-6284	INFO System	DOS/W3.11 W95 WNT3.51 WNT4.2	6+	2 with 3 more in progress	1995	SDS, Traffic Signal Preemption	Lotus, Excel, ODBC
Canadian Marconi Company * 514/748-3070	ALLSTAR SUPERSTAR	DOS/W3.11 W95 WNT3.51 WNT4.2	50+	10	1995 1998	SDS	ASCII
McCain Traffic Supply	TOTE	DOS/W3.11 W95 WNT3.51	1+	3	1993	Automatic Vehicle ID	ASCII, ODBC, etc.
Navigation Data Systems, Inc. (NDS) 504/734-5566	Fleet-Trak	DOS/W 3.11 W 95	10+	8	1980	SDS, AVL, proprietary GIS	ASCII, etc.
Rockwell International 319/295-9138	Transit Master	DOS/W3.11 W95 WNT3.51 WNT4.2	50+	7	1995	MDT, Smart Card, SDS	Dbase
Transportation Management Solutions, Raytheon E-Systems 410/850-7890	Fleet Service AVL	W95 WNT3.51 WNT4.2	11+	8	1994	SDS, MDT	Dbase, Lotus, Excel

*Only sold to end users through systems integrators.

Table 2.8.1b: AVL Vendors

Training and Cost Information								
Company Name	**Product Name**	**Initial Training Period**	**Initial Training Cost**	**Additional Training Cost / Day**	**Cost per Vehicle**	**Base Unit Software Cost**	**Base Unit Hardware Cost**	**Software Maintenance Fee**
3M	INFO System *	5 days	Included	$800-$1,000	Call for quote	Call for quote	Call for quote	Call for quote
Canadian Marconi Company	ALLSTAR ** SUPERSTAR	None**	Included	**	$400+ $100-$300	$10,000	$3,000	**
McCain Traffic Supply	TOTE	5 days	$400/ day	$400	$2,000 +	$10,000 +	5,000/ dispatcher	10-15% of S. W. Cost
Navigation Data Systems, Inc. (NDS)	Fleet-Trak	3 days	Included	$700	$1,000 - $2,000	$15,000 - $1,800,000	$5,000- $1,200,000	$500-$45,000
Rockwell International	Transit Master	2-3 days	Included	$800	$3,000 +	***	***	2-4% of S. W. Cost
Transportation Management Solutions, Raytheon E-Systems	Fleet Service AVL	3-5 days	Not Included	$1,000	$1,000 +	$7,000 +	$10,000+	2-4% of System Cost

*3M Info System is an integrated on bus AVL, CPU system which tracks schedule adherence on the bus and reports exception only. It also includes the interface between the on-bus systems and the communication system and the interface between the base unit software and the communication system. It is primarily used in fixed route operations in conjunction with traffic signal priority equipment.
** Only sold through systems integrators. Instructions for integrators are supplied in manual form, email help, and web page of FAQ's. Questions with double asterisks are not appropriate for this company.
*** Included in MDT Cost.

Table 2.8.2: MDT Vendors

General Information							
Company Name	**Product Name**	**Operating System**	**Suggested # of Vehicles**	**Transit Installations**	**Date of First Installation**	**Interfaces with**	**Exports To**
GMSI Inc. 919/785-7073	4100 Series Mobile Data Terminal	WNT 4.2	50+	3	1986	SDS, AVL, Smart Card, GIS, Odometer Readers, Barcode Readers, Magnetic Swipes, Onboard Monitoring Devices	ASCII, ODBC, etc.
Mentor Engineering 403/777--3760	Express +	W95, WNT 4.2	11+	15	1994	AVL, Smart Card, Odometer Readers	ASCII, etc.
Rockwell International	Transit Master	DOS/W3.11 W95 WNT3.51 WNT4.2	50+	7	1995	AVL, Smart Card, SDS	Dbase

Training and Cost Information									
Company Name	**Product Name**	**Initial Training Period**	**Initial Training Cost**	**Additional Training Cost / Day**	**Cost per Vehicle**	**Base Unit Software Cost**	**Base Unit Hardware Cost**	**Vehicle Unit Annual Maintenance Fee**	**Base Unit Annual Software Maintenance Fee**
GMSI Inc.	4100 Series Mobile Data Terminal	2-3 wks.	Included	$600	$1,500 - $2,000	$20,000	$2,500	$72	$3,000
Mentor Engineering	Express +	1-3 days	Included	$500	$1,250	*	$1,500 - $10,000	$70	$2,000- $3,000
Rockwell International	Transit Master	2-3 days	Included	$800	$3,000 +	$25,000 +	$20,000 +	5% of hardware cost	2-4% of Hardware and Software Cost

*Some base unit software included with terminal purchase. Custom, installation specific software will also be needed

** AVL vendors which serve as system integrators such as Orbital, Raytheon, and 3M will supply MDT's as needed for use with their AVL systems.

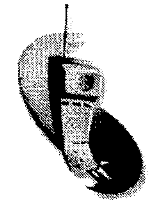
Table 2.8.3: Smart Card Vendors

General Information							
Company Name	**Product Name**	**Operating System**	**Suggested # of Vehicles**	**Transit Installations**	**Date of First Installation**	**Interfaced with**	**Exports To**
Smart Card International 904/323-0490	Smart Card Transportation Program	DOS/W3.11 W95 WNT3.51 WNT4.2, UNIX	6-50+	Varies	Varies	Scheduling and Dispatch Software	DBASE, ASCII, Lotus, Excel
Royal Bank of Canada 416/348-5492	Mondex	Multos	50+	1		Smartcard terminals on buses	None

Training and Cost Information									
Company Name	**Product Name**	**Initial Training Period**	**Initial Training Cost**	**Additional Training Cost / Day**	**Cost per Vehicle**	**Base Unit Software Cost**	**Base Unit Hardware Cost**	**Vehicle Unit Annual Maintenance Fee**	**Base Unit Annual Software Maintenance Fee**
Smart Card International	Smart Card	Installation/ Program Dependent	Included	Varies	Varies with each vehicle/ program	Varies with each vehicle/ program	Varies with each vehicle/ program	15%	Varies with each vehicle/ program
Royal Bank of Canada	Mondex	Pilot Product, N/A	Pilot Product, no cost information	Pilot Product, no cost information	Pilot Product, no cost information	*Pilot Product, no cost information	Pilot Product, no cost information	Pilot Product, no cost information	Pilot Product, no cost information

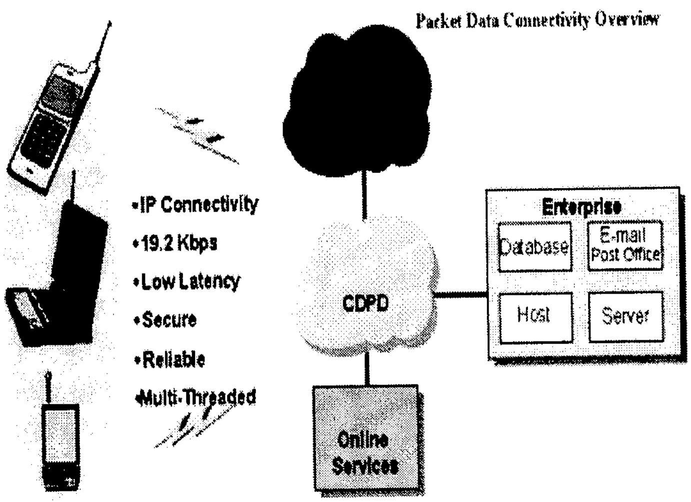
crowded, other communications techniques will be applied. Some of these methods of are described below and include mobile and cellular phones, digital data packets, and spectrum options.

Commercial mobile radios are widely used for both voice and digital data transmission. They will continue to be used for some time, especially in conventional communications that require relatively little data transmission.


Cellular

Cellular phones are used in many systems as effective means of communication. These are simple and relatively inexpensive. The local transit system does not have to build radio infrastructure like transmission towers, rather they rent the service of a cellular provider.

Cellular Digital Package Data (CDPD) allows users to send and receive data by cellular phones. It integrates state-of-the-art data networking technologies with the existing cellular infrastructure in a transparent manner to provide wireless data services. It was designed to work with existing data networks. As the adjacent figure indicates CDPD expands communications options from person-to-person or vehicle-to-control center to other origins and destinations. The data could originate on the Internet, an on-line service or the transit control center. It would then be transmitted to the driver or on-vehicle computer system. As discussed previously decentralized architectures that permit more direct passenger-to-driver communication are possible and CDPD may be the essential component for these new approaches.



The transmission network and related elements are "transparent" for the communications technology, from the perspective of a transit operator, yet the network elements and related issues may have at least tangential impact on the selection of communication technology. Some of these elements are discussed below.

Satellites represent an expensive, though feasible method of replacing ground-based transmission towers that are the basis of standard radio, cellular, MDT, and CDPD communication. They are particularly useful for communication in remote areas.

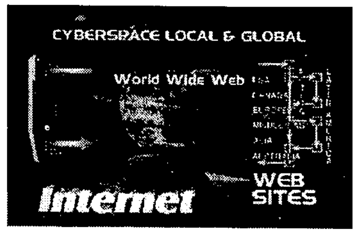
Spread spectrum broadcasting transmits a low power signal over many frequencies and uses "receiver intelligence" to decode the information. The FCC does not licensed spread spectrum applications.

Shared spectrum transmission frequencies are shared with transit and non-transit users. This may be an inexpensive way to obtain radio voice or data transmission if a reserved frequency is not available. It is not desirable for essentially continuous transmissions that would occur with many vehicles in a fleet transmitting AVL updates and MDT messages.

FM/AM Sub-carriers piggyback on the radio signals from existing stations instead of reserving a radio frequency for exclusive use.

Integrated radios combine commercial mobile radio and the newer technologies. For example, "start kit" installations of MDT's will usually share the voice radio that is already installed in the vehicle. As the digital communication traffic grows, a separate frequency will eventually have to be acquired.

The *Internet* is basically a collection of networks bound together physically by high-speed cabling and linguistically by a common communications language. One of the most interesting features of the Internet is its graphical point-and-click interface. Other popular sections of the Internet include electronic (or e-) mail, Usenet (which is a collection of newsgroups) and FTP (File Transfer Protocol, a language that allows transferring files between any computers, no matter what type, anywhere in the world). Also the search engines like Lycos, Yahoo, Excite and others are useful tools for finding information on the web.



More and more transit agencies are acquiring Internet facilities which seems to be on the verge of becoming a method of communication as revolutionary as the telephone. For additional information see the following Internet site: (http://www.ctaa.org/resource/rtap/ib/newtech.htlm). The Internet provides a quick, easy and inexpensive link to share information with almost anybody, almost anywhere. It can provide a wide range of functions from marketing a transit system to distributing reports, from identifying suppliers and their products to distributing important technical information. An Internet user can view and download Internet-posted information.

There are also complementary options to the Internet. New technology is being introduced to allow Internet sites to be seen and used over cable television (http://envisionlink.com/envision/transit/welcome.html). Besides this web TV, Internet is also becoming interactive with the telephone by providing access to it through the cable television (http://www.resptv.com/comaccess.html). With more TV and telephone innovations connected to the Internet, transit operators in small urban and rural areas will be able to reach their passengers in the remote areas and thus will enhance their services.

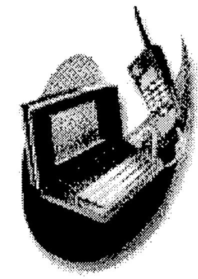
2.9 Emerging Technologies

Internet dispatching uses conventional desktop computers with Internet access to a central provider of dispatching and scheduling services.

Wireless Internet dispatching is being introduced at various sites. This makes the transit systems more distributed that results in decreasing local capital investment, less local staff training less local maintenance and places more reliance on a service provider for Internet and web page for dispatching. This Internet dispatching system relies on small "superphones" with

Internet access at the user site, long distance telephone (satellite) connections and server capacity at the provider (http://www.instepmobile.com).

Superphones are essentially small hand-held, light weight computers with two-way phone capability and Internet access. Currently these phones sell for $100 to $400. It is called a wireless Internet because the Cellular Digital Package Data (CDPD) works on TCP/IP protocol and electronic mails can be received on these phones as well. Mobile data terminals can also be coupled with a CDPD modem. Superphones provide drivers with e-mail directly to the cars, direct two-way data and voice communication, so drivers can respond directly to customers. Superphones have Cellular phone and Internet capabilities, and can handle e-mail as well as access specially enabled web pages for dispatching and other uses. It can also get access to Airline Flight Info, Phone Number lookups, Map Directions, sports, news, and weather too.



Wireless Data

InStep and AT&T distribute such devices, and transit agencies in the Santa Clara area are using them. Both vendors offer an affordable dispatching solution using web pages and superphones capable of wireless data and voice. InStep offers "Superphone" computer automated dispatching systems for as low as $65/dispatcher/month and $35/superphone/month with no large up-front capital costs. AT&T offers the "PocketNet" for $99 including the phone, two extended NiMH batteries, and a desktop cradle charger. CDPD airtime pricing for the PocketNet phone is about $30 to $40/month for as much data as a person wants to use. These solutions allow smaller companies to step straight into computer automated dispatch with minimal capital investment.

Personal data assistant's (PDA's) are small hand-held computers that electronically reproduce driver manifests, among other functions. They replace paper and pencil data entry with driver data entry. This helps speed data collection and processing for billing and system performance reports. Loaded with a day's worth of trip data, drivers pick up the PDA's every morning and return them to the office at the end of the day. Each day's data is downloaded and the PDA is recharged. It accomplishes the combined job of a scheduling and dispatching software and a MDT but with less capital cost and more driver effort. Transnet is offers a PDA for transit. PalmPilot is a powerful general purpose PDA. Sharp also makes a good PDA.

Smartmaps are gaining popularity (http://www.smartmaps.com). Smartmaps are versatile information products that can serve many purposes. System maps, route schedules, interactive kiosks, and bus stop graphics are a few of the diverse products that evolve from the map design.

Smart bus technology that communicates bus location, bus stop and other information to passengers is being used in many countries. Transit has to look attractive and be efficient. The German Ruf-Bus uses big maps of the city area that has buttons to push denoting the destinations for a passenger. The system gives a pick-up time and after acceptance of the trip, a receipt is printed with the arrival time of the bus on it. The German system also works with any special phone or even a home phone. In the US, there are plans to provide demand responsive service to riders with a maximum of 2 to 3 intermediate stops. The plan includes several touch computer screens (in hotels and casinos) and many special telephones (outside) where a demand response bus or van can be ordered.

The **Internet** also constantly offers new products. There is the *Web-TV*, which is very inexpensive compared to the personal computers required to access web-sites. The Web-TV equipment cost about $300, connects to home TVs, and permits simultaneous viewing of television programs and the Internet sites. Blacksburg Transit in Virginia transmits its Internet web-site and real-time display of transit vehicle location on community access cable television. This is an inexpensive passenger information system. The cost for this setup is about $2000 for equipment and $50 per month for telephone line and Internet charges. The cost however does not include web-site development, automatic vehicle tracking, or cable connection charges. (bjames@ctr.vt.edu). Then there is also the Cable TV with Telephone Control. It provides passengers access to the transit Internet site or other specified agency sites. It does not provide total Internet access. In contrast to Web-TV, you have to pay for the service of your passengers instead. Such a service is operating in Iowa City. The cost for the service to the city or transit agency might vary from $4000 to $10,000 annually depending on the number of passengers served. Special hardware cost may exceed $3000 (http://www.resptv.com).

Although many of these technologies are still being used in Taxis only, it will not be long before these are also introduced to transit. Although the benefits of computerized dispatching are already well recognized, the addition of cellular and digital data makes these systems cost effective for smaller fleets as well.

2.10 APTS Technologies and Safety

Safety is of prime concern for any transit system. Technology is expected to ensure safety for the passengers as well as the drivers. But sometimes this does not work as expected. Automatic Vehicle Locators (AVL), radios, cellular phones and others give the exact position of a vehicle in times of trouble and thus aid in rescue work. Mobile Data Terminals are used to transfer messages to drivers quickly from the dispatcher. But some exhibit a man-machine interface problem. They are hard to read, especially if a vehicle is in motion, and the display panel is not in the natural line of sight but rather to the side and down on the instrument panel. Drivers have reported accidents while reading MDTs, however, they are reluctant to blame the device for the accident. Among some of the suggestions made to improve these situations include moving up the keyboard to eye level near the top of the dashboard, training drivers the use of MDTs, use of voice dispatch etc.

2.11 Section Summary

This report is grounded on the premise that improved passenger service and system productivity result from appropriate applications of Advanced Public Transportation Systems (APTS). The appropriate use of APTS technology ultimately resides with local transit managers. However, these men and women have the support of a growing field of experts bound together by nationally recognized technology standards and APTS architecture to assure compatible integration of software and hardware options.

Computerized scheduling and dispatch software (CADS) is the "brain" for APTS systems for small urban and rural demand responsive transit operations. Various categories or "levels" of CADS are available depending on the needs and operations characteristics of transit systems. The levels are: off-the-shelf software, custom database applications, semi-automated CADS and automated CADS. Each software level offers increasingly more transit operations functionality usually at increasing cost. With semi-automated and fully automated software level transit managers may also implement complementary APTS hardware options to further improve service. They include mobile data terminals (MDTs), automatic vehicle location (AVL), and smart cards. Tables in this chapter provide detailed information on many current APTS software and hardware vendors and their products. Since APTS technology develops and changes rapidly, this chapter gives a preview of emerging innovations. Of particular note is the use of the Internet for all forms of transit communication between drivers, dispatchers, passengers, agencies, etc.

Chapter 1 defined the problems facing small urban and rural transit operators as they attempt to provide new services and the issues involved. Chapter 2 identified APTS software and hardware options that should play a significant role in improve services. The next chapter of this report will summarize how small urban and rural transit operators have appropriate applied APTS to their own local problems. These case studies will help other systems in their APTS selection process and they identify contacts for peer-to-peer advice.

Section 3
Case Studies of
Small Urban and Rural Transit Systems

3.1 Introduction

Section 1 of this report described the service and delivery problems and related issues that face transit operators in small urban and rual areas. Section 2 presented a variety of APTS technology solutions that can help transit operators deliver service more efficiently and effectively. This section of the report will describe a number of case study transit systems that have used APTS technology to meet their needs.

This chapter contains cases that other transit operators can compare their situations to and make some early judgements about what might or might not work for them. It serves to improve peer-to-peer communication on the topic of APTS in small urban and rural areas. The collected data also serve to verify the Internet APTS assessment and selection methods that Section 4 develops.

This section begins with the survey approach used to develop the case studies. Then the discussion describes the transit system data collection effort and results that are also summarized as tables.

3.2 Transit System Surveys

The study team distributed a national MTAP alert to state departments of transportation requesting them to identify small urban and rural systems for this study. The MTAP results were added to system names culled from a literature review and from discussions with APTS professionals. Then the study team developed a series of mail-back and fax-back surveys that were sent to 32 small urban and rural public transportation operators. The survey instrument obtained information on technology systems implemented, approaches to implementation, problems encountered, and technology upgrades planned. From this pool, ten representative sites were selected for in-depth telephone interviews. These detailed telephone interviews form the basis of the case studies. The case study interviews go beyond the written survey and provide insight into the selection and implementation issues that face operators.

3.3 Mail/Fax Survey Responses

Thirty-two public transportation systems responded to the survey (Appendix C). Of the 15 systems that reported their organizational structure, five systems were municipal/city systems and nine systems were regional or county systems; four of the latter were multi-county systems. Of the 17 systems that reported their service setting, five were small urban, one was suburban/rural, three were rural, and eight were small urban/rural or urban/rural. Some general observations from these surveys include the following:

- 30 systems use at least one APTS technology.

- CADS is the most common technology implemented. 29 systems have CADS. Of all the APTS technologies, rural systems have only fully implemented CADS. No rural system had fully implemented MDTs, AVL, or Smart Cards.
- 11 of the 32 transit systems use two or more technologies, typically CADS and AVL.
- AVL is the second most common technology in operation. Eight systems use AVL with CADS, and one transit system reports AVL as its sole technology.
- Only four systems use MDTs. Three of these systems also have CADS and AVL, and one system has CADS and MDTs.
- Only two systems report using multi-media traveler information systems to complement their APTS technologies.

3.4 Telephone Interviews

Approach

The telephone interviews provided in-depth information. The interviews represent transit systems from diverse geographic areas, a mix of populations, and a mix of urban and rural locations. They represent various stages of technology. The following ten public transportation systems comprised the telephone interviews (Table 3.1):

1. ARC Transit, Inc. - Florida
2. Arrowhead Transit - Minnesota
3. Blacksburg Transit - Virginia
4. Cape Cod Regional Transit Authority - Massachusetts
5. County of Lackawanna Transit System (COLTS) - Pennsylvania
6. Kerr Area Transportation Authority (KARTS) - North Carolina
7. Mendocino Transit Authority - California
8. Seacoast Transportation (COAST) - New Hampshire
9. Sweetwater County Transit Authority (STAR) - Wyoming
10. Winston-Salem Transit Authority (WSTA) - North Carolina

The study team primarily interviewed the system manager. If the manager was not available then other managerial staff were interviewed. Interviews lasted approximately 60 to 90 minutes and follow-up calls were made as needed to clarify data. The operators were very willing to discuss their implementation and to share their insights so that others may benefit from their experience.

Telephone Interview Results

APTS Implementation

The ten case study sites represent both rural and small urban areas. The majority operate demand-responsive service. Only one system, COLTS, operates fixed-route service solely. Two operate both demand-responsive and fixed-route service (Blacksburg Transit and Mendocino

Transit Authority). One operates a flex-route and demand-responsive service combination (ARC Transit).

The service areas of the ten transit systems range from 15 square miles to 20,000 square miles. Their service area range in population from 41,000 to 397,484.

The 10 case study systems are representative of the following transit service markets:

- High growth, self contained communities
- Slow or no growth, self contained communities
- Largely sparsely populated rural areas
- Rural tourist areas.

Seven out of the ten sites have implemented some type of APTS system. The breakdown by technology is as follows (Table 3.2):

- CADS (6)
- MDTS (1)
- AVL (3 full implementations; 2 partial implementations on limited number of vehicles)
- Electronic fare card media (1 full implementation; 2 partial implementations on limited number of vehicles)
- Kiosk (1)

Cape Cod Transit and COAST have not yet implemented any technologies but are in the process. Mendocino Transit Authority abandoned its CADS software.

Needs Assessment

Depending on the stakeholders and other factors, the approach to conducting a needs assessment varied among the case studies. There were some reoccurring themes. Several of the case study sites had the goal of utilizing the APTS technologies to centralize dispatch functions. The majority of the case studies reported that the major goal of APTS technology implementation was to increase customer service and enhance productivity. Refer to Table 3.3 which identifies transit system needs and APTS solutions selected to meet these needs.

Cost/Benefits

None of the case study sites have fully documented the costs and benefits of their APTS solution. Most have recognized that the personnel time during the implementation stages is more extensive than anticipated. This is due to the data entry, learning curve adapting to automation, and difficulty of use of the technologies. Some reported that the CADS software requires extensive customization and is difficult to adapt to rural operational needs. Refer to Table 3.4 for an overview of cost/benefits from the perspective of the transit operator. A more in-depth discussion of these APTS implementations and insight into implementation issues are provided in Section 5 of this report.

3.5 Section Summary

This section of the report presented the results of case study transit system surveys and interviews. The surveys of 32 small urban and rural transit systems reveal that nearly all of the respondants use APTS technology, especially CADS. About half (25%) use two or more techonologies, typically CADS and AVL or MDT. No rural system has fully implemented MDTs, AVL, or smart cards. The in-depth interviews of 10 transit systems revealed that APTS techonogies are used primarily to increase customer service and enhance system productivity, though little or no quanitative data support the achievement of those objectives. The number and variety of APTS plans for the future suggest that transit managers have confidence in technology solutions for their transit service needs.

Table 3.1: Information on Case Studies

Transit System	City/State	U.S. Region	Transit Service Market [1]	Service Type [2]	Service Area (sq. mi.)	Service Area (pop.)	Ave. Daily Trips	Peak Vehicles
Arc Transit, Inc.	Palatka/FL	SE	4	HS/GP Dial-A-Ride	798	69,516	520 DR	15 Flex-Route 15 DR vans
Arrowhead Transit	Virginia/MN	MW	4	HS/GP Dial-A-Ride	20,000	200,000	1,400 DR	53 DR vans
Blacksburg Transit	Blacksburg/VA	SE	1	FR/ADA/HS, GP Dial-A-Ride	15	45,000	9,100 FR 54 DR	29 FR buses 8 DR vans
Cape Cod Regional Transit Authority	Cape Cod/MA	NE	5	FR/ADA/HS Dial-A-Ride	400	200,000	254 FR 1,099 FR (summer) 713 DR	N/A
COAST	Durham/NH	NE	4	HS/GP Dial-A-Ride	1,065	397,484	900 DR	15 DR vans
COLTS	Scranton/ PA	NE	2	FR/ADA	164	180,000	5.205 FR	32 FR buses
KARTS	Henderson/NC	SE	4	HS/GP Dial-A-Ride	2,102	159,544	1,000 DR	51 DR vans

Table 3.1: Information on Case Studies (continued)

Transit System	City/State	U.S. Region	Transit Service Market [1]	Service Type [2]	Service Area (sq. mi.)	Service Area (pop.)	Ave. Daily Trips	Peak Vehicles
Mendocino Transit Authority	Ukiah/CA	W	4	FR/ADA/GP Dial-A-Ride	3,188	83,998	900 FR 393 ADA/GP & DR	21 FR buses 18 ADA/GP DR vans
STAR	Sweetwater/WY	NW	4	HS/GP Dial-A-Ride	10,400	41,000	346 DR	14 DR vans
Winston-Salem Transit Authority	Winston-Salem/NC	SE	1	FR/ADA/HS Dial-A-Ride	400	320,000	350 DR	21 DR vans

[1]Transit Service Market:
1= High Growth, Self Contained Communities; 2= Slow or No Growth, Self Contained Communities; 3= Rural to Metropolitan Commuting Areas
4= Largely Sparsely-Populated Rural Areas; 5= Rural Tourist Areas

2 Service type: HS = human services; GP= general public; FR = fixed route; DR = dial-a-ride, demand responsive

Table 3.2: Case Study Technology Profiles

Transit System	Technologies Implemented [1]	Technologies Planned	APTS Success? (Yes/No/Pending)
Arc Transit, Inc.	Semi-automated CADS (custom) Magnetic Stripe Fare Cards (test on 13 vehicles) AVL (test on 13 vehicles)	Add electronic fare cards for all vehicles Expand AVL to all vehicles	YES/PENDING (AVL and electronic fare cards are only tested on a few vehicles)
Arrowhead Transit	AVL (American Mobile Satellite) MDTs (American Mobile Satellite)	Fully-automated CADS (Midas)	YES/PENDING (AVL and MDTs installed; Fully-automated CADS procured but awaiting upgrade)
Blacksburg Transit	Fully-automated CADS (Intellitrans) AVL: (Hyperdyne with Trimble GPS) Kiosk	Internet homepage Dedicated cable TV channel Telephone-based system Bus stop display	YES/PENDING (Fully-automated CADS, AVL, and Kiosk are operational; other technologies are not yet implemented)
Cape Cod Regional Transit Authority		AVL MDT SmartCard Internet-based customer information system	PENDING
COAST		Fully automate CADS (Midas) AVL, AVL	PENDING (Fully-automated CADS procured and pending installation; other technologies are not yet procured)

[1] For Cape Cod and COAST implementation is not completed.

Table 3.2: Case Study Technology Profiles (continued)

Transit System	Technologies Implemented [1]	Technologies Planned	APTS Success? (Yes/No/Pending)
COLTS	AVL (Auto-Trac) MDTs (GMSI) SmartCards Voice Annunciator (Digital Recorder)	No immediate plans	YES
KARTS	Semi-automated CADS (MiniPASS)	No immediate plans	YES
Mendocino Transit Authority	Fully-automated CADS (PASS)	No immediate plans	NO
STAR	Semi-automated CADS (Dispatch-A-Ride)	Fully-auto CADS,AVL, MDTs SmartCards	YES/NO (Semi-automated CADS installed; other technologies were planned but funding fell through)
WSTA	Fully-automated CADS (PASS) AVL - test on 3 vehicles MDTs (Mentor) – test on 3 vehs SmartCards - test on 3 vehicles	AVL, MDTs Rideshare Software	YES/Pending (Fully-automated CADS installed; planned technologies pending RFP)

Table 3.3: Case Study Needs and Technology Solutions

Transit System Name	Identified Needs	Technologies Implemented	Technologies Planned
Arc Transit, Inc.	To streamline customer billing To monitor vehicle location	Semi-auto CADS (Custom) Electronic Fare Card (Magnetic Stripe Cards) – test on 13 vehicles AVL – test on 13 vehicles	Expand electronic fare card to all vehicles Expand AVL to all vehicles
Arrowhead Transit	To integrate communications between highway and transit To facilitate centralized dispatching	AVL (American Mobile Satellite) MDTs (American Mobile Satellite)	Fully-auto CADS (Midas)
Blacksburg Transit	To enhance communication with the customer To monitor vehicle location	Fully-auto CADS (Intellitrans) AVL: (Hyperdyne with Trimble GPS) Kiosk	Internet homepage Dedicated cable TV channel Telephone-based system Bus stop display
Cape Cod Regional Transit Authority	To improve regional trip coordination	N/A	AVL MDT SmartCard Internet-based customer information system
COAST	To facilitate centralized dispatching To coordinate transfers To streamline customer billing	N/A	Fully-auto CADS Software (Midas) AVL MDTs

Table 3.3: Case Study Needs and Technology Solutions (continued)

Transit System Name	Identified Needs	Technologies Implemented	Technologies Planned
COLTS	To reduce customer complaints To reduce costs To eliminate need for street supervisors	AVL (Auto-Trac) MDTs (GMSI) SmartCards Voice Annunciator (Digital Recorder)	No immediate plans
KARTS	To streamline customer billing To assist with trip scheduling	Semi-auto CADS (MiniPASS)	No immediate plans
Mendocino Transit Authority	To facilitate centralized dispatching To streamline paperwork processes To improve vehicle productivity	Fully-auto CADS (PASS)	No immediate plans
STAR	To streamline customer billing To assist with trip scheduling	Semi-auto CADS (Dispatch-A-Ride)	Fully-autoCADS, AVL SmartCards, MDTs
WSTA	To assist with trip scheduling To facilitate communications between dispatch and drivers To track vehicle location	Fully-auto CADS (PASS) AVL - test on 3 vehicles MDTs (Mentor) - test on 3 vehicles SmartCards - test on 3 vehicles	AVL, MDTs Rideshare Software

Table 3.4: Costs/Benefits

Transit System	Technologies Implemented [1]	System Costs [2]	Funding Sources	System Benefits	System Disadvantages
Arc Transit	Semi-auto CADS (Custom) Electronic Fare Card (Magnetic Stripe Cards) – test on 13 vehicles AVL – test on 13 vehicles		State demonstration grant	More efficient customer billing process	
Arrowhead Transit	AVL (American Mobile Satellite) MDTs (American Mobile Satellite)	$245,000	FTA demo site: 80% federal;10% state; 10% local	More efficient communications between highway and transit Improved communications between dispatch and drivers	
Blacksburg Transit	Fully-auto CADS (Intellitrans) AVL: (Hyperdyne with Trimble GPS) Kiosk	N/A	FTA demonstration site: 80% federal;10% state; 10% local	Improved customer communications	
COLTS	AVL (Auto-Trac) MDTs (GMSI) SmartCards Voice Annunciator (Digital Recorder)	$400,000	$320,000 federal; $66,667 state; $13,333 local	Reduced customer complaints Reduced personnel costs (eliminate need for street supervisor) Maintain liability costs	Maintenance is costly

Table 3.4: Costs/Benefits (continued)

Transit System	Technologies Implemented [1]	System Costs [2]	Funding Sources	System Benefits	System Disadvantages
KARTS	Semi-auto CADS (MiniPASS)	$8,000	90% state; 10% local	More efficient customer billing process Greater staff accountability	Excessive paper produced for back-up reports Verification of billing calculations is difficult
Mendocino Transit Authority	Fully-auto CADS (PASS)	N/A	80% federal; 20% local	N/A	CADS is not designed for rural operations. CADS requires extensive customization
STAR	Semi-auto CADS (Dispatch-A-Ride)	$50,000	80% federal; 20% local	More efficient customer billing process	Semi-auto CADS is limited for trip scheduling assist
WSTA	Fully-auto CADS (PASS) AVL - test on 3 vehicles MDTs (Mentor) – test on 3 vehicles SmartCards - test on 3 vehicles	N/A	FTA demonstration site: 80% federal;10% state; 10% local	Improved trip scheduling, Improved communications between dispatch and drivers	Hardware/software compatibility problems. Other integration problems.

[1] Cape Cod and COAST are not included in this table since implementation is not completed.
[2]Costs are estimated and include training but excludes personnel costs associated with implementation

Section 4
Choosing APTS Technology

4.1 Introduction

Section 1 of this report established the problems and needs of various small urban and rural transit systems. On the other hand, Section 2 provided potential solutions using advanced technologies that are available in the market. After establishing the passenger and transit system needs and gathering information on technologies, operators have to decide what to buy. This is not an easy task. Help is available from other transit operators, vendors and professional journals. Another approach, is a computerized decision support tool that matches technologies to transit needs. This section describes such a tool to assist rural and small urban transit operators. It assesses basic system characteristics through a series of questions to the operator and suggests technologies that have proved successful elsewhere. The tool, which is accessible on the Internet, also provides much information on vendor contacts and technology characteristics. The Internet address for the tool is:

http://www2.ncsu.edu/eos/ service/ce/research/stone_res/tahmed_res/www/index.html.

4.2 Problem Statement

Transit operators in small urban and rural areas can effectively use new technologies to help them meet a variety of service challenges. Technologies such as computer aided dispatch and scheduling, mobile data terminals and automatic vehicle location can improve fleet productivity. Other technologies such as smart cards, passenger information systems, web TV and the Internet can help improve passenger service. By substituting APTS technologies for traditional manual methods of dispatching trips, vocie radio, tedious bookkeeping, etc., managers will find that they can expand their operations into a spectrum of mobility management services. To make effective technology choices transit managers, especially those in smaller and more rural areas, must use up-to-date information in a rational decision process. They must match their operational needs and characteristics of their fleet and passengers to various functionalities of AOOTS technology. The following paragraphs explore such decision factors and propose new methods for making APTS technology choices.

<u>Decision Factors</u>

Some of the basic needs of a transit system are reporting, billing, inefficiency of staff or schedules, expanding demand etc. In many cases there remains no option but to experiment with APTS technologies and learn from trial and error. What works best for one transit authority may not work at all for another. However, fundamental characteristics of local services, fleet size, service area and ridership provide strong hints of what technologies will work. The ratio of demand responsive trips to subscription trips also suggests appropriate APTS technologies that may be chosen within cost and funding constraints.

Service area - As mentioned in Section 1, the characteristics of the service area influence the technology choice. At the CTAA Annual Meeting in 1997, rural communities were characterized into five distinct market segments (Boenau, 1997). These market segments have different income and age groups with different transportation needs. Table 4.2.1 suggests different APTS solutions for different market segments (James, 1996).

Table 4.2.1 Typical Software for Rural Areas

Rural Market Segment	**Scheduling and Dispatching Software**
Self-contained high growth local communities	Fully-automated scheduling and dispatching software
Self-contained slow/no growth local communities	Fully-automated or semi-automated scheduling and dispatching software
Large sparsely populated rural areas	Fully-automated scheduling and dispatching software
Rural to metropolitan commutes	Fully-automated scheduling and dispatching software
Rural Tourist Areas	Fully-automated or semi-automated scheduling and dispatching software

The simplistic suggestions of Table 4.2.1 are a starting point for APTS evaluation. A "Quick Assessment" method developed in this report uses the results of Table 4.2.1. More sophisticated evaluation occurs through the "Detailed Assessment" based on Tables 4.2.2, Table 4.2.3 and other information like fleet size. Usually the higher level software like the semi-automated and fully automated are compatible with other complementary hardware like the AVL, MDT and others. Table 4.2.2 gives a description of the technologies applicable to the various area types.

Fleet size - The more the number of vehicles, the more complex the scheduling and dispatching process. When scheduling software is used for small demand responsive system (fewer than 10-15 vehicles), it may simply assist the human scheduler in the process of assigning a vehicle to a trip request. This is often referred to as "computer assisted" scheduling. Such computer-assisted methods include off-the-shelf and custom applications. On the other hand, larger fleets require higher levels of computer automation for the trip assignment and vehicle scheduling process, to the point where full automation is a near necessity for systems of 50 or more vehicles (Lave, 1996). The decision support assessment methods in this chapter use the fleet and software information of Table 4.2.3.

Table 4.2.3: Typical Software Based on Fleet-Size

No. of operating vehicles	**Software recommendations**
Less than 10 operating vehicles	Lower level of software
Greater than 10 and/or less than 30 operating vehicles	Intermediate level of software
Greater than 30 operating vehicles	Higher level of software

Number of trips per day and number of demand responsive trips per day - For systems having less than 500 trips per day, a database software package is adequate (Lave, 1996). For greater than 500 trips per day, but fewer than 150 demand trips, computer-assisted scheduling is adequate, and for greater than 500 trips and greater than 150 demand trips, automated scheduling is warranted. Table 4.2.4 summarizes the information incorporated into the "Detailed Assessment" method.

Table 4.2.4: Typical Software Based on Trip Types

No. of trips and trip type	**Software recommendations**
Less than 200 subscription trips	Lower level of software
Greater than 200 but less than 500 subscription trips and/or less than 150 demand responsive trips	Intermediate level of software
Greater than 500 subscription trips and/or greater than 150 demand responsive trips	Intermediate level of software
Greater than 500 subscription trips and/or greater than 250 demand responsive trips	Higher level of software

The "Quick" and "Detailed" assessment methods mainly take into account the area type, trip numbers, trip type and fleet size. But there are other fundamental requirements that are important for technology selections:

- Good transit management
- good training available
- adequate funds
- technical capabilities of staff
- technical "readiness" of the transit system

Without these prerequisites for APTS, the procurement should not proceed. (Also, please see Sections 5 and 6).

4.3 Scope and Objectives of the Decision Support Tool

This study includes all types of small urban and rural transit operations including traditional dial-a-ride, welfare-to-work, ADA complementary paratransit service, rural human service contracted and general public service, single county and multi county contract transportation and general public services. The decision tool focuses on subscription and demand responsive paratransit services. The tool does not specifically consider fixed route services and taxi services. It was developed from the perspective of a transit manager who faces technological decision problems. This section will guide transit operators in the selection of software rather than be a "consumer report" on APTS products. Since APTS technology changes so rapidly, adaptive assessment methods will have a longer lifetime than a static technology ranking that will inevitably be outdated.

The proposed APTS decision tool that includes the Quick Assessment and the Detailed Assessment uses information from vendor and transit system surveys, case studies, the Internet and personal communications. It is based on information collected from hardware and software vendors, software features and capabilities, hardware compatibility, communication standards, operating systems, some cost-benefit information and most importantly summaries from case studies reflecting prevailing situations in selected transit systems.

Scheduling and dispatching software of various levels (off-the-shelf, custom database application software, semi-automated, and fully automated). Complementary hardware like AVL, MDT, smart cards, Internet, and other emerging technologies are included in the assessment tools as "add-ons" to the Semi-Automated or Automated CADS .

The Internet provides the medium for the decision support tool so that it has quick, universal accessibility for managers, transit authority members and others who need to review APTS technology and make choices. The Internet also allows easy updating of information. However, the decision tool has not been developed to provide the absolute answer to the choice of technology. It does provide a guide to the selection of the technologies and supporting information like vendor lists with product name and vendor address, price and training information. The tool further includes search engines and other transit Internet site information.

The specific objectives for this effort are:

- To develop a decision support tool to help small urban and rural transit managers to match their service needs to appropriate technology options especially scheduling and dispatching software and complementary hardware.
- To make the decision support tool widely accessible.
- To include relevant tutorial information about APTS technologies.
- To develop a resource on small urban and rural transit operations, and issues.

The proposed method is called a tool rather than a method because not only does it involve a procedure for decision making, but also relevant information on the recommendation like vendors, costs, etc. The methodology adopted is based on information from case studies, telephone interviews, vendor and user surveys. The case studies are described in Chapter 3 and Appendix D. The literature search provided relatively little information for the assessment tool. Not many small urban and rural transit operations use APTS and even fewer have documented the experience, especially cost-benefit data.

Table 4.2.2: Potential APTS Solutions for Small Urban and Rural Areas

AREA CATEGORIES	CATEGORY IDENTIFIERS	TYPICAL SERVICE NEEDS	POTENTIAL APTS SOLUTIONS	
			Software	Compatible Technologies
Self Containea High Growth Local Communities	- serves employment and retirement communities - economically prosperous, higher percent of work trips - competition with autos for riders	- coordination of transportation providers - accommodation of multiple trip purposes - service enhancements to attract discretionary trips	-Fully-Automated software	- AVL, MDT - smart cards - automated passenger counts - navigational aids - communication links
Self Contained Slow/No Growth Local Communities	- presence of aging and declining population - stagnant economy - high unemployment - high demand for social services - few transportation options - high number of transit dependent riders	- coordination of social service providers - automation of scheduling and routing - efficiency of record keeping and billing - encouragement of volunteerism	-Fully-Automated software -Semi-Automated software	- AVL, MDT - smart cards - communication links
Rural to Metropolitan Commutes	- long distance commutes through rural areas - from dispersed to concentrated origins or destinations - communities with strong metropolitan links - opportunities for high trip volumes	- connection to urban transit systems - utilization of vehicles during off peak hours - high reliability and avoidance of traffic delays	-Fully-Automated software -Automated rideshare matching	- AVL, MDT - automatic passenger counts - automated annunciators - communication links - dynamic vehicle routing
Large Sparsely-Populated Rural Areas	- low population density - low trip volume/demand - long trip distances	- reliable communication links - coordination of distant service providers - emergency notification and response	-Fully-Automated software -Automated rideshare matching	- AVL, MDT - smart cards - emergency billing - navigational aids - communication links
Rural Tourist Areas	- large seasonal variation of demand - congestion during peak tourist seasons - numerous small service providers	- utilization of capital equipment - accommodation of both tourists and service workers - informing customers of services	-Fully-Automated software -Semi-Automated software	- AVL, MDT - traveler info systems - auto public address system - automatic passenger counts - communication links

References: James 1996, Casey, Boenau 1997

Before a transit manager decides to acquire APTS technology, several "prerequisites" must be satisfied:

- Is there a need for APTS?
- Will the expected benefits exceed costs?
- Is there consensus support among management, staff, drivers and board members for the technologies?
- Are funding, procurement, implementation and training plans conceptualized (if not actually written)?

If the answer is "yes" to these questions, the transit system is technologically ready for APTS.

The decision tool assumes these prerequisites are satisfied. It then proceeds interactively from the perspective of small urban and rural transit operators. The web page mechanizes the design tool. The user provides information about his/her transit system, and the web-based decision tool leads to a final product or in some cases may lead to information which will help in making the right technology choice. By answering a series of questions the user is guided through a decision tree structure. The decision tool addresses major issues like, type of rural segment, type of services provided, number of trips, fleet size, needs of the system, and others.

4.4 Methods for Choosing APTS Technology

As an introduction to deciding what APTS technology to implement, this section will describe the alternative approaches and characteristics of good approaches. Then the proposed decision tool will be developed.

4.4.1 Current Methods

It is clear from the contents of the previous sections that technology can help significantly if the right choice is matched to the right situation. But there still remains the question, as to how appropriate technology can be matched to specific transit system needs. No standard procedure is followed by transit agencies in the country in making decisions about technologies. Transit systems use several approaches to make technology decisions:

- Ad-hoc, informal assessment of problems and solutions
- Decisions based on the advice of other transit operators
- Demonstrations and information gathered locally at conferences and other transit systems
- Decisions based on the advice of a hired integrator or consultant
- Subjective evaluation and scoring
- Formal cost-benefit estimation

Although cost-benefit estimation should provide the most quantitative results, in most cases it is quite impossible to gather the required financial, transit performance, and service information. In some cases it is advisable to hire technical consultants who are familiar with recent APTS innovations and can make informed diagnosis of transit ills and technological cures. Information from colleagues and other transit managers is always useful, also.

4.4.2 General Methodology for Decision Making

The following steps should be followed when making technology selections.

- Assess needs of passengers, system, management etc.
- Review technologies for software, hardware and related items
- Visit sites and conduct demonstrations
- Design conceptual APTS systems based on functionality and specifications of hardware and software
- Estimate APTS costs and benefits of competing technology options
- Select the most appropriate technology option

Some of the evaluation methods that can be used to choose technology are described below.

Single-Criteria Evaluation Method (Cost-Benefit Analysis) - Various methods of deciding between options exist in transit and other fields. In single criteria evaluation methods, all the benefits and costs are usually reduced to monetary terms. The present worth, annual cost, benefit-cost, and rate of return methods all fall into the category, because the maximization of net benefits is the single objective the analyst has in mind. Although quantitative methods of evaluating alternatives like cost-benefit analysis are the most efficient method, some benefits are more qualitative rather than quantitative, for example, customer satisfaction, etc. Ideally the alternative with the lowest cost-benefit ratio should be.

Multi-Criteria Evaluation Method - This method is quite the reverse of the single-criteria evaluation method. Here several objectives (or criteria) are considered. For example, a project may contain the following objectives:

- To improve passenger service measured by decreased ride time.
- To improve transit productivity measured by passengers carried per vehicle mile.
- To be financially affordable including initial cost, upgrade cost, training, maintenance, etc.
- To use new technology that local staff, drivers, management and passengers accept.

Decision Tree Method - A decision tree has a tree-like structure with multiple nodes and branches. Each of the branches coming out of a node depicts a decision or choice. In many cases the branches involve a cost. The optimum path through the tree represents least cost with greatest expected returns.

Expert Assessment - Usually decision making can be described as a process for formulating and analyzing decisions about the future, for which significant resources must be committed in the present. Sometimes highly experienced personnel heuristically guide the decision, based on their experience.

Scoring Method - In this method, each of the measures of effectiveness is given a quantitative or qualitative weight or importance. Then the options are scored and ranked.

4.4.3 Characteristics of a Good Decision Method

A good decision method is assumed to have the following characteristics.

- Multi-attribute - more than one type of measure of effectiveness criteria is considered.
- Cost - usually low cost is desirable.
- Reproducible - the method should be reproducible and consistent.
- Interactive - active transfer of information and data between user and method, with immediate feedback is important.
- Accessible - the method should be accessible and widely available.
- Self-documenting - the method should document input information and results.
- User friendly - attractive methods that guide and instruct will be more acceptable.
- Adaptable - if minimal data is available, the method should "educate" the user and suggest possible choices. The method should also be able to do analysis if the user has extensive information.
- Efficient - the method should have flexible time requirements depending on the amount of time the user can spend.

Table 4.4.1 shown below compares the characteristics of a good decision support tool between those belonging to other methods and the proposed decision support tool. The proposed decision support tool offers many advantages. It is free, simple, fast, self-documenting, etc.

Table 4.4.1: Decision Methods

	Methods					
Characteristics	**Cost/ Benefit Analysis**	**Scoring Method**	**Decision Tree**	**Site visit**	**Expert Assessment**	**Proposed Tool**
Multi-attribute	no	possible	no	possible	possible	yes
Cost	high	high	low	high	high	low
Reproducible	yes	possible	yes	yes	possible	yes
Interactive	no	no	possible	yes	yes	yes
Media	traditional*	traditional*	traditional*	traditional*	traditional*	Internet
self documenting	possible	possible	possible	no	no	yes
User friendly	no	possible	no	yes	yes	yes
Workable with minimal data	no	no	no	yes	yes	yes
in-depth analysis with extensive data	yes	yes	yes	yes	yes	yes
Accessible	low	low	low	low	low	high
fast information update	possible	possible	possible	not possible	possible	possible
Simplicity	no	possible	no	yes	yes	yes
Time requirement	high	high	high	high	high	low

*Traditional media include pencil, paper, and computer analysis.

4.5 The Proposed Decision Support Tool

Considering the aforementioned current APTS decision methods, general decision methods, and factors for good decision methods, the following conceptual method and prototype decision support tool are proposed. After describing and demonstrating the decision support tool, which has an Internet interface and Quick and Detailed Assessment options, verification of results will be discussed based on the case studies of Chapter 3 and comments from "beta test" users.

4.5.1 Conceptual Decision Support Tool

Various factors can influence the decision making process, and the proposed decision tool takes into consideration most of the important ones. The overall concept behind the decision support tool can be shown with the following flowchart.

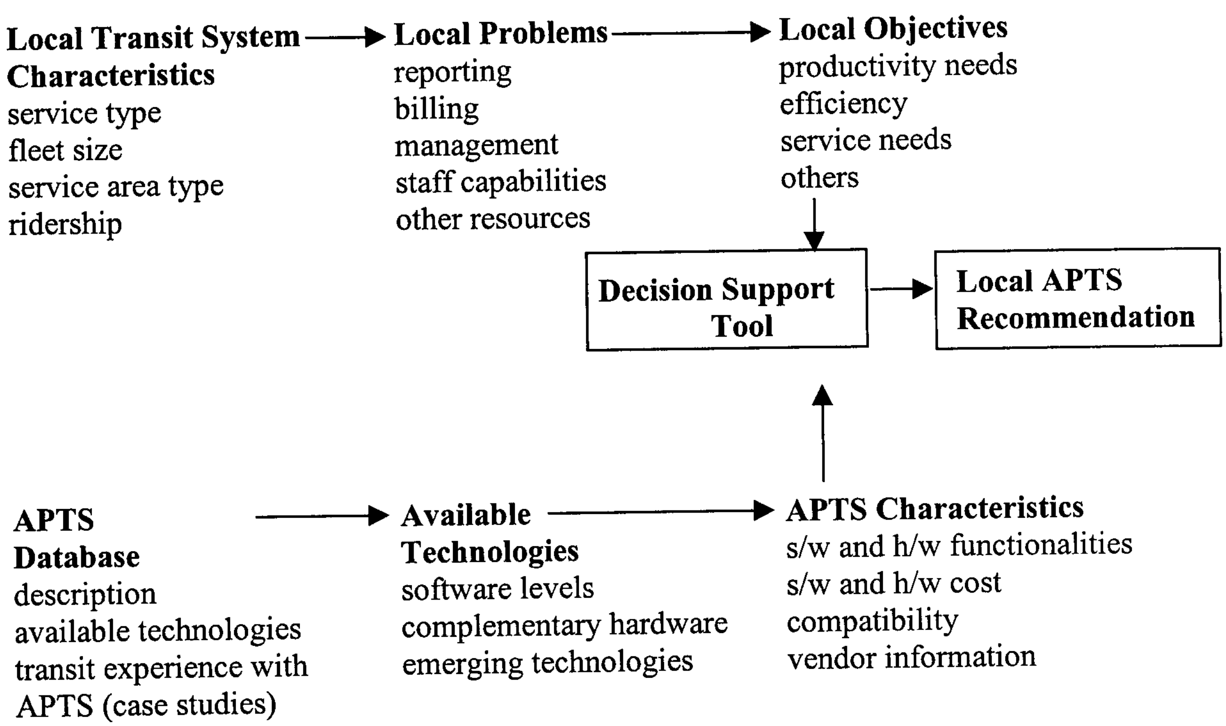


Figure 4.5.1: Decision Support Tool Flowchart

The decision support tool contains two distinct parts. One part is the input information provided by the user and the other is the database that feeds into the model the necessary information to provide the recommendation. Different systems will have different problems based on the system characteristics, and this will lead to specific transit system objectives. The information database contains technology definitions, their types, cost and other information regarding software and hardware. The decision tool will make recommendations by matching the input information to the information in the APTS database. Thus, the decision support tool provides the "best fit" recommendation for the system. Along with the suggested level of software and hardware, the tool provides other information. The user can look vendor phone or email addresses, product and training costs, information, etc. Web sites are identified if he or she desires to learn more about the recommended technology.

Transit operators access the decision support tool through the Internet. The overall picture of the tool may be visualized from Figure 4.5.2. The small urban or rural system manager answers a series of questions that help to describe his/her system. This is the interactive part of the tool. Based upon this given information, the decision support method matches this information to that existing in the database. The database contains information and inferences gathered from surveys, case studies and journals. The recommended solutions are given based on a matching process described in Section 4.2 and summarized in Figure 4.5.3.

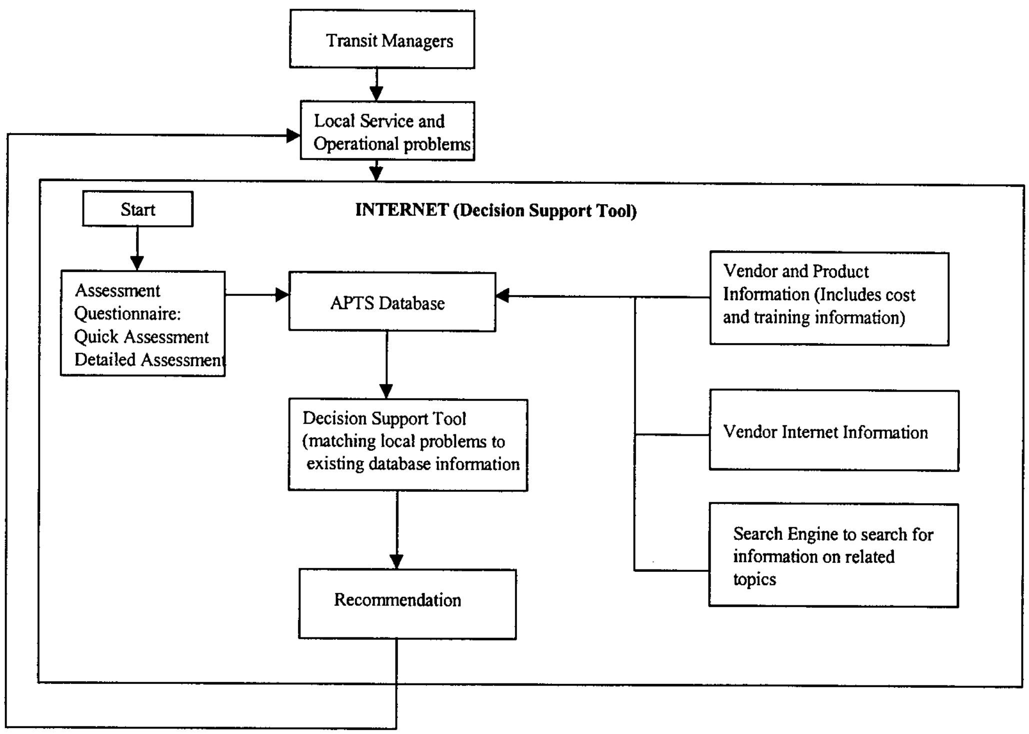


Fig 4.5.2 Internet Implementation of the Decision Support Tool

4.5.2 Important Features of the Decision Support Tool

The decision support tool contains a Quick Assessment and a Detailed Assessment method, which will be demonstrated below. Important features of the development of the decision support tool are its medium and the programming language.

Medium

The internet implements the decisions support tool, which is not just a method, but is a source of complete reference to related information. Non-technical terms and visual elements enhance and explain the questionnaire form. The decision tool is self-explanatory. Based on the information provided by an operator on his/her system, the operator will be given a recommendation about the type of software and hardware to use.

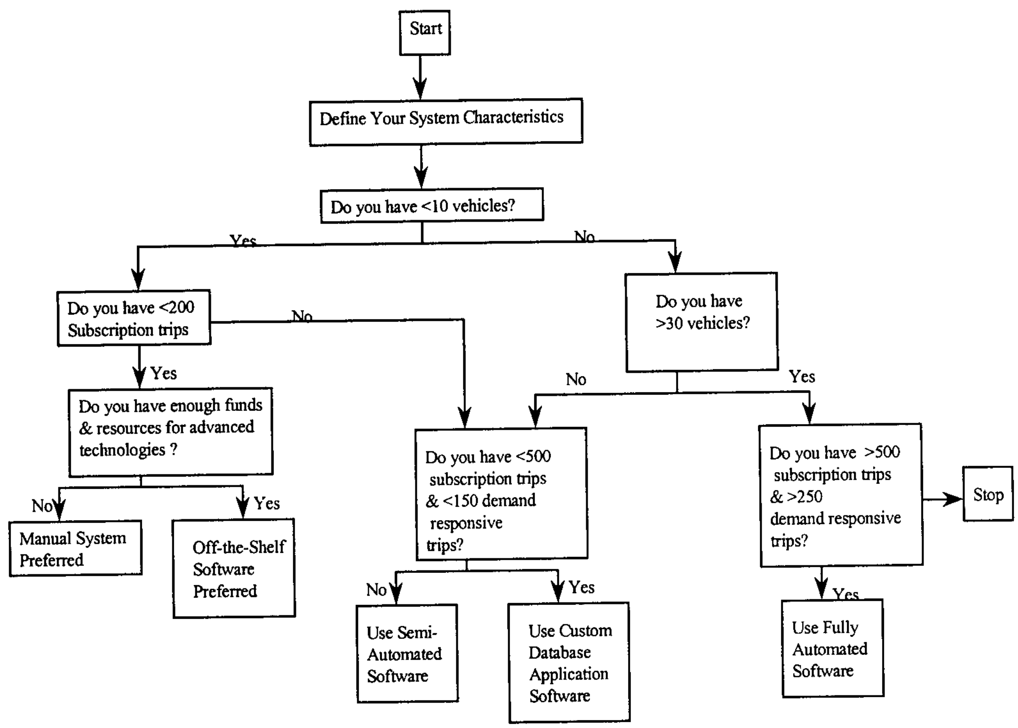


Figure 4.5.3: Decision Tree for the Detailed Assessment Approach

The Internet can be defined as a vast collection of inter-connected networks that all use the TCP/IP protocols (Transmission Control Protocol/Internet Protocol) and that evolved from the ARPANET of the late 60's and early 70's. Compared to the other representation media like reports on paper copies, reports on journals, the Internet is the most convenient media to deliver fast-paced, fast-changing information on technologies to the user if a computer and access to the Internet are available. The information on the Internet can be easily changed and updated. The flexibility of moving from one site to another within seconds is possible. The Internet is probably the most advanced way to represent interactive methods. It is getting more popular everyday and new inventions like web-TV are entering the market. The only disadvantage of using the Internet as the media may be that some systems in remote rural areas do not have Internet connections. The URL for the site is: http://www2.ncsu.edu/eos/service/ce/research/stone_res/tahmed_res/www/index.html.

Programming Language

The decision support tool uses JavaScript, a scripting extension to HTML. It improves the ability of the tool to respond to user input without the need for client-server communication or CGI (Common Gateway Interface) scripting. It provides a solution for client-side scripting in an era when users with high-powered machines get bogged by client server communication. Although many ways exist to control the browser from within a Java applet, simple tasks such as computing a form or controlling frame content become complicated affairs. JavaScript bridges the gap by enabling HTML authors to implement basic HTML functionality and interactivity.

Other Features

Besides the Quick and Detailed Assessments the web page also contains the following information:

- vendor names, address and training information for the software and hardware
- descriptions of software and hardware technologies
- description of emerging technologies
- addresses to related sites
- search engine for finding sites of interest
- on-line reference to the entire project report

Limitations of the Assessment Methods

While developing the decision support tool, a few problems occurred. In real situation the method for software and hardware selection is not only dependent on factors like the number of vehicles, number of trips, type of trips, and other issues. These are not inserted in the decision tool directly, but it is assumed that they are noted and accounted for by the transit manager in the selection process. These include:

- availability of adequate budget
- present status of technology
- specific needs of a system
- available computer platform and technology resources
- technology state of staff
- upgradability and training facility of a technology

Again, every system in each small urban and rural area is unique. So, a software or hardware suitable for one system may not work well for another system belonging to the same market segment. Also, very little has been done on rural and small urban areas with regard to cost-benefit and other decision analysis. Developing criteria for technology selection is a problem. For example cost-benefit ratio would have been a desirable criterion for the selection process. The intention of the decision tool was not to provide a unique solution for a system. It provides initial guidance and APTS education for the operators, who may be technophobic or ignorant of APTS.

While the information on which the decision tool was based on is ever changing with time and needs to be updated with time, the links to related sites will help update site information.

4.5.3 Quick Assessment Method

Description

Two types of assessments are produced in the decision tool - the Quick Assessment and the Detailed Assessment. The Quick Assessment can be used when the user is interested in quick results and has limited data. The Quick Assessment is based only on market area type with the assumption or hypothesis that smaller services use less complicated and less expensive software (Section 1). Actually other transit system characteristics (e.g. fleet size, trip-type, and the number of daily trips) and local needs (reporting and billing problems, driver supervision, and data management) play strong roles in determining what specific hardware and software will best solve local problems. The Detailed Assessment addresses these characteristics. After recommending a certain software and hardware, both assessment methods provide supplementary information regarding cost, equipment and staff training. A "snapshot" of the Quick Assessment Internet page is shown in Figure 4.5.4.

Sample Application and Verification of the Quick Assessment Method

Case Study Area - Arrowhead Transit, Minnesota
(Market Segment Type: Large Sparsely Populated Rural Area)

By comparing the actual area characteristics of Arrowhead Transit to typical characteristics of the various market segments (Table 4.2.2), it is found that that Arrowhead belongs to the "large sparsely populated rural area" category. This market segment category is the input to the Quick Assessment method, which uses this information to recommend software for the transit system (Table 4.2.1).

Table 4.5.1 compares output from the Quick Assessment method to the technology actually in use in the study area. The Quick Assessment market results for the Arrowhead Transit case compare very well with the actual situation. The software and hardware recommendations given by the Quick Assessment method also match with the ones actually being operated in the area.

Similar comparisons for the purpose of verifying the Quick Assessment method were accomplished for all ten case study areas. Table 4.5.2 shows that the Quick Assessment method provides appropriate software recommendations for the seven cases and failed for one case, excluding the areas no software in use. For two of such cases comparison was not possible. These areas are Cape Cod, and COLTS who did not have any software in service or planned. Although Blacksburg and COLTS also has fixed route services, the Quick Assessment method recommends for the area because this assessment method is based on area types rather than on trip types. Colts only has fixed route services. The assessment method is applicable specifically to the demand responsive trips.

Some of the study areas for which comparison was possible are already using various software and hardware and some are in the planning stage of technology use. For areas like STAR and COAST, the recommendation matched with the software planned, not with the software that is currently in use. But only for KARTS the software recommendation did not match with the actual software being implemented. The Quick Assessment recommended a higher level of software than the one in use This can be explained very easily. The assessment recommends the most appropriate technology for an area. An area may use a lower or higher level than the one recommended based on special needs, and its resource availability. For almost all the cases the hardware recommendations matched with actual situation even though for some cases there was partial match. For example Blacksburg transit is currently using AVL and has plans to install MDTs. The decision support tool recommends Smart Cards in addition to AVL and MDT. The same situation prevails for Arrowhead Transit. Thus, transit managers may be confident that using the Quick Assessment will give reasonable results, or at least a starting point for more detailed evaluations.

Table 4.5.1 Arrowhead Transit: Application of the Quick Assessment Method

Market Identifiers given by Quick Assessment	- low population density - low trip volume/demand - long trip distances
Actual Arrowhead Market Identifiers	- low population density - low trip volume/demand - long trip distances
Identified Market Needs by Quick Assessment	-reliable communication links
Actual Arrowhead Market Needs	-centralize call taking and dispatching functions -improved communication between vehicles -improved communications between centralized dispatching and vehicles
Quick Assessment Software Recommendation	-fully-automated software
Software Used or Planned by Arrowhead	-Midas PT Fully-Automated software
Quick Assessment Hardware Recommendation	-AVL, MDT, Smartcard
Hardware Used by Arrowhead	AVL, MDT

Table 4.5.2: Summary Table Showing Comparison of the Results from the Quick Assessment Method and Actual Situation

Transit System	Quick Assessment Market Segment	Actual Market Segment	Quick Assessment Software	Actual Software Used/Planned	Quick Assessment Hardware	Actual Hardware Used/Planned
Arc Transit, FL	Large sparsely populated rural area	Large sparsely populated area	Semi-Automated software	Semi-Automated CADS software	AVL,MDT, Smart Cards	Electronic fare cards, AVL
Arrowhead Transit, MN	Large sparsely populated rural area	Large sparsely populated area	Fully-Automated software	Fully-Automated software	AVL, MDT , Smart Cards	AVL, MDT
Blacksburg Transit, VA	Self-contained high-growth community	Self-contained high-growth community	Fully-Automated software (mostly fixed route services)	Fully-Automated software	AVL,MDT, Smart Cards	AVL: Hyperdyne (Trimble GPS), Kiosk. Planned MDT
Cape Cod Transit, MA	Rural tourist area	Rural tourist area	Fully-Automated software	No software currently in use	AVL, MDT	*Planned: AVL, MDT, Smart Card, Internet-based customer information system
COAST, NH	Information not available	Large sparsely populated area	Fully-Automated software	*Planned: Fully-Automated software	AVL,MDT, Smart Cards	Planned: AVL, MDT
COLTS, PA	Slow or no growth self contained community	Slow or no growth self contained community	Fully-Automated or Semi-Automated software (all fixed route services)	No software planned yet	AVL,MDT, Smart Cards	AVL, MDT, Smart cards
KARTS, NC	Large sparsely populated area	Large sparsely populated area	Fully-Automated software	Semi-Automated software	AVL,MDT, Smart Cards	N/A
Mendocino Transit Authority, CA	Large sparsely populated area	Large sparsely populated area	Fully-Automated software	Fully-Automated software (Although they have stopped using the software)	AVL, MDT Smartcard	No s/w or h/w currently in use
STAR, WY	Large sparsely populated area	Large sparsely populated area	Fully-Automated software	Semi-Automated software. *Planned: Fully-Automated software	AVL,MDT, Smart Cards	Planned: AVL, MDT, Smart Cards
Winston-Salem Transit Authority, NC	High-growth self contained community	High-growth self contained community	Fully-Automated software	Fully-Automated software	AVL,MDT, Smart Cards	AVL, MDT, Smart Cards

Note: CADS - Computer -Aided Dispatching Software DRT - Demand Responsive Transit AVL - Automatic Vehicle Locator
SDS - Scheduling and Dispatching Software MDT - Mobile Data Terminal GPS - Geographic Positioning System

Figure 4.5.4: Quick Assessment Internet Page

QUICK ASSESSMENT INTERVIEW

This is the Quick Assessment page, where depending on your type of service area (market segment), a category of Scheduling and Dispatching Software will be suggested for your transit system. This suggestion will be followed by other information applicable to that software category.

Note that the Quick Assessment is based only on market segment types. It assumes that smaller systems require less complicated and less expensive APTS hardware and software. Actually other transit system characteristics (fleet size, trip type, number of trips) and local needs (reporting, billing problems, driver supervision, data management) play strong roles.

Software Options Based on Service Area Type

Please tell us who you are (optional):

Name :

Address :

Organization:

Email :

Phone Number:

Which type of service area does your transit system operate in?
(Check only one type, and press 'Submit'. To unselect a chosen option, click on the box a second time.)

- [ ] Self-Contained High Growth Local Community
  - More Information
- [ ] Self-Contained Slow/No Growth Local Community
  - More Information
- [ ] Rural to Metropolitan Commute
  - More Information
- [ ] Large Sparsely Populated Rural Area
  - More Information
- [ ] Rural Tourist Area
  - More Information

For the recommended software, press 'Submit'.

Submit

For a summary table of potential APTS solutions for small urban and rural areas, click on 'SUMMARY' below.

· SUMMARY

This concludes the Quick Assessment interview. To proceed with the Detailed Assessment, choose the Detailed Assessment option from the left column containing 'Topics'.

If you would like to enter your name and address in our guest register, please press the 'Guest Register' button below. Otherwise your visit will be anonymous. In either event, your information is confidential and will not be used for any marketing purpose.

Guest Register

4.5.4 Detailed Assessment Method

Description

In the Detailed Assessment Method, the fleet-size, number and type of trips were handled in three ways.

- Systems with a fleet-size of less than 10 vehicles and less than 200 subscription trips have the option of either using Off-the-Shelf or the Manual system. This decision may be based on the funding position and the specific needs of the area.
- Systems with a fleet-size between 10 and 30 have the option of choosing between the Custom Database Application software or Semi-Automated software depending on the ratio of the subscription and demand responsive trips. These thresholds may vary in different situations. For less than 500 subscription trips and less than 150 demand responsive trips, the assessment method recommends Custom Database Application Software. If the values are higher than those thresholds, Semi-Automated software is recommended.
- Systems with a fleet-size of more than 30 vehicles, more than 500 subscription trips and more than 250 demand responsive trips should use Fully-Automated software. The flowchart in Figure 4.5.3 shows the decision tree based on this classification. The decision thresholds are based on operational experiences and vendor recommendations.

In the selection of hardware, problems of the systems were given importance. Problems were selected according to those usually observed in the rural and small urban transit systems. Some of the widely prevailing problems were chosen to recommend the hardware applicable to a system. These are billing, reporting, security and driver supervision problem. A snapshot of the Detailed Assessment page from the web-based decision support tool is shown in Figure 4.5.5.

Sample Application and Verification of the Detailed Assessment Method

Case Study Area - Arrowhead Transit, Minnesota
(Market Segment type: Large Sparsely Populated Rural Area)

The characteristics that were input information for the case study area are shown below. These were matched to the decision tree branch information (Figure 4.5.3). The table also shows the comparison of the recommendation provided by the Detailed Assessment method to the technologies already in use in the study area.

From Table 4.5.4 shown above, it is evident that the recommendations from the Detailed Assessment method match actual Arrowhead operations, software and hardware. Based on the service characteristics, the Detailed Assessment recommends fully automated software. As there was no break down of trips, it was assumed that the third option of the trip choices match because of the large number of total trips.

The other case studies provide similar comparisons for the purpose of verifying the Detailed Assessment method excluding the three study areas, with fixed route services or with no technology in implementation phase or planning phase. The summary results of Table 4.5.4 show that the Detailed Assessment method provides appropriate software recommendations for six out of seven of the case study areas. Comparison was not possible for three of the cases, Cape Cod, COLTS and Blacksburg transit. Again some of the comparisons were performed with the planned technologies and some with currently used technologies. In Cape Cod, there is no software in use and in COLTS, all trips are for fixed route services and this could not be inserted in the assessment method as the method only deals with demand responsive services. Also in Blacksburg area, most of the services are fixed route. The few number of demand responsive trips seem too low a value for Fully Automated software. Sometimes the software in use is chosen based on the available resources rather than based on needs. For KARTS, NC however the recommended software did not match the actual software in use. The hardware recommendation matched the hardware in use for most of the case study areas, if not fully at least partially. This indicates that more criteria need to be inserted for the method to give a more exact match. The results indicate that the Detailed Assessment could provide satisfactory recommendations in most cases to guide transit operators in their technology selection.

Table 4.5.3 Arrowhead Transit: Application of the Detailed Assessment Method

Fleet-size option (Detailed Assessment)	>30 operating vehicles
Actual Arrowhead fleet size	52
Number and type of trips (Detailed Assessment)	> 500 subscription trips, and > 250 demand responsive trips
Actual number and type of trips	Total 1500 No break down of trip types found
Software Recommendation (Detailed Assessment)	Fully-Automated software
Software Used or Planned by Arrowhead Transit	Fully-Automated software
Hardware Recommendation (Detailed Assessment)	-for reporting, billing, fleet management problems use MDT and AVL
Actual Hardware Used by Arrowhead	-for record keeping MDT and AVL are used

Table 4.5.4: Summary Table Showing Comparison of the Results from the Detailed Assessment Method and Actual Situation

Transit System Name and Location	Market Segment	Detailed Assessment Suggested Software	Actual Software Used/Planned	Detailed Assessment Suggested Hardware	Actual Hardware Used/Planned
Arc Transit, FL	Large sparsely populated area	Fully-Automated or Semi-Automated software	Semi-Automated CADS software	MDT, Smart Cards	Electronic fare card, AVL
Arrowhead Transit, MN	Large sparsely populated area	Fully-Automated software	Fully-Automated software	AVL, MDT	AVL, MDT
Blacksburg Transit, VA	Self-contained high-growth community	Mostly fixed route, lower level of software recommended for the 54 demand responsive trips	Fully-Automated software	Information not available	Planned :AVL, Kiosk MDT
Cape Cod Transit, MA	Rural tourist area	Fully-Automated software	No software currently in use	AVL,MDT, Smart cards	Planned: AVL, MDT, Smart Card, Internet-based customer information system
COAST, NH	Large sparsely populated area	Fully-Automated or Semi-Automated software	Fully-Automated software	Information not available	MDT Planned: AVL, MDT
COLTS, PA	Slow or no growth self contained community	All fixed route trips	No software currently in use	AVL	AVL, MDT, Smart cards
KARTS, NC	Large sparsely populated area	Fully-Automated software	Semi-Automated software	MDT, Smart Cards	N/A
Mendocino Transit Authority, CA	Large sparsely populated area	Fully-Automated software	Fully-Automated software	No hardware recommended	No hardware currently being used
STAR, WY	Large sparsely populated area	Semi-Automated software	Semi-Automated software Planned: Fully-Automated software	AVL,MDT, Smart cards	Planned: AVL, MDT, Smart Cards
Winston-Salem Transit Authority, NC	High-growth self contained community	Fully-Actuated CADS software	Fully-Automated software	AVL, MDT, Smart Cards	AVL, MDT, Smart Cards

Note: SDS - Scheduling and Dispatching Software; AVL - Automatic Vehicle Locator; DRT - Demand Responsive Transit
CADS - Computer -Aided Dispatching Software; GPS - Geographic Positioning System; MDT - Mobile Data Terminal

Figure 4.5.5: Detailed Assessment Internet Page

DETAILED ASSESSMENT INTERVIEW

This is the Detailed Assessment page, where depending on your system needs and the problems you face, software and hardware options will be suggested for your transit system. This suggestion will be followed by information on vendors, cost etc.

CHOOSING SOFTWARE:

Please tell us who you are, and press 'Guest Register'(optional). Your information is confidential.

Name :
Address :
Organization:
Email :
Phone Number:

Guest Register

1.What is your fleetsize?
Select

2. Describe the number and type of trips handled by your agency:
Select

For the recommended software, press 'Submit'

Submit

CHOOSING HARDWARE

If Semi-Automated or Fully-Automated software has been recommended for your system, then depending on the following specific needs of your system, complementary hardware may be helpful. See the tables for Software and Hardware Vendors for information on compatibility, cost and other software and hardware issues.

3. Which of the following problem(s) does your system face? (Check as many as applicable and then press the "Submit" button below)

- **Billing Problems**
- **Reporting Problems**
- **Security Problems**
- **Driver Supervision**
- **None**

For the recommended hardware, press 'Submit'

Submit

This concludes the Detailed Assessment interview. Thank you for using the Assessments. We hope it was helpful.

4.5.5 User Response to Decision Support Tool

Professionals in various transit positions tested the decision support tool and its assessment methods. Among the people who provided valuable feedback were transit managers, FTA engineers, university researchers, a decision analyst, computer consultants and software and hardware vendors. They were contacted by email and asked to comment on the following issues:

- Utility of the tool to guide decision making
- Appropriateness of the recommendations from the assessments
- The usefulness of the vendor tables of APTS technology
- Utility of the tutorial type structure of the web-site

Most of them agreed that the decision support tool is very usable. Some showed concern over the accessibility of the Internet by small urban and rural users, though more and more are coming on-line. One of the more valuable suggestions was to provide demonstrations of software.

4.6 Summary

The decision support tool is an information resource for transit decision-makers in small urban and rural transit systems. Some of the factors that make the tool an appropriate one are its efficiency, accessibility, upgrade features, as well as validity. The vast information source for software and hardware vendors, cost information make the tool a complete reference for choosing technology options in the remote rural areas.

From the comparison of the results of the decision support tool and that from the case study surveys, it can be concluded that both the Quick Assessment and the Detailed Assessment methods work. The fact that the Internet was chosen as the media has also proved to be very helpful. "Beta test" users have had easy access to try it out. The clickable features make the tool very easy and convenient to use. But the site has to be maintained and needs to be updated with time. New technologies along with new information need to be fed to the tool. Many systems go for the higher level of software because they have the resources and available staff to handle the new sophisticated product. Again for many of the systems, technologies fail due to other reasons, such as inefficiency of staff and others. So, choosing the right technology for a system does not assure better efficiency of that system. Often technology if not properly implemented could cause severe harm to the system. The decision support tool can be further improved by adding more criteria of selection in the methods. For example the Detailed Assessment method used trip number, type and fleet size for analysis. But from prevailing situations it can be seen that there are many other factors related to the selection process. These can be incorporated for further expansion of the tool. Again, more research needs to be performed on cost-benefit issues of the technologies being used in small urban and rural transit systems. Also in future, the tool may be implemented and synthesized with other contemporary decision design methods with the help of further research.

Section 5
Case Studies for APTS Implementation

5.1 Introduction

How should I begin to convert to an APTS-based transit system? How can I get the most value for the dollar invested? Can I truly realize benefits as a small public transportation system?

These questions can be answered by a careful, well thought out implementation plan. Such a plan will help to minimize problems during implementation and will help to assure that transit operations are getting the most appropriate customized technology(ies) to meet operational needs. It is significant to note that the transit-specific products that are available commercially are not yet at the level of "plug and play". Customization is required for any system selected, so it is the responsibility of the manager to clearly define current operations and outcomes expected from the new technology(ies) in an implementation plan.

Many public transportation operations managers have already struggled through the implementation process. The case studies in Section 3 and Appendix D illustrate some of the measures taken and problems encountered through all phases of APTS planning, procurement, and implementation.

This section focuses on how the 10 case study sites approached implementation, and it discusses some of the lessons learned in the process. The following topics organize this section on APTS implementation:

- Vision for APTS Technologies
- Needs Assessment
- APTS Technology Selection
- Procurement, Funding, and Implementation
- APTS Benefits and Problem
- Future APTS Plans

5.2 Vision for APTS Technologies

At each of the case study sites, one or more persons had a vision of how APTS technology could be an effective tool in increasing productivity and overall system performance. In all of the case studies, the public transportation manager took a leadership role that was critical for success. The commitment was there even though most of the managers interviewed did not have a strong technical background.

In three of the case examples, the state DOT also took a strong leadership role (KARTS, Arrowhead, and WSTA), and they helped to support and/or pursue funding or fund the effort directly. KARTS was one of 20 sites in a statewide procurement and implementation process. The Arrowhead and WSTA sites had a vision for integrating the technologies within their in-house public transportation services and traffic operations. In addition, both systems wished to enhance connectivity between fixed-route and demand response services.

At COAST, the local United Way provided the initial impetus for change. The Greater Seacoast United Way of Durham, New Hampshire conducted a survey of city and county residents to assess the needs of the community. The results of the survey helped to prioritize the funding of activities to meet those needs. Transportation was identified as one of the areas most deficient, and as a result transportation issues began to surface as a priority. The state Department of Health and Human Services also contributed to the effort by funding equipment.

At WSTA and Blacksburg Transit the managers developed partnerships with local universities to accomplish research components and to help with procurement and implementation.

5.3 Needs Assessment

Early in the implementation process, the case study transit managers recognized the importance of building consensus with their Board transit staff and other partners. Most managers reported establishing a core review team that was involved in decision-making from concept to system selection. Dispatchers and drivers are key staff to involve in the early planning phases of implementation.

The majority of the case studies reported that the major goal of APTS technology implementation was to increase customer service and enhance productivity. Other problems to overcome included:

- Inefficient utilization of fleet
- Poor mechanisms for documenting trips and associating trips to a billing source
- Declining ridership
- Inadequate passenger communication systems
- Burdensome record-keeping
- Concerns about fraud
- Inefficiencies in regional coordination
- Inadequate radio coverage
- Lack of connectivity between services
- Poor communication between vehicles

For example, Arrowhead Transit and COAST each had a goal of centralizing call-taking and dispatching in one regional entity. COLTS, the only system of the ten case studies solely operating a fixed-route system, established a cost savings goal. With the technologies in place, COLTS anticipated eliminating the need for two street supervisors and stabilizing liability costs by having access to back-up data from the AVL system to defend them against passenger liability claims.

5.4 APTS Technology Selection

Having identified transit system needs that are potentially amenable by APTS technology, transit system managers must identify the APTS technology functionalities (or capabilities) that are appropriate for their problems. This requires learning about the functionalities for the various APTS technologies. The following are ways in which transit managers at the case study sites enhanced their understanding APTS.

- Participation in national ITS conferences
- Visiting other public transportation systems with similar operational characteristics and needs
- Organizing a vendor workshop in state
- Reviewing the literature
- Contacting other public transportation professionals and technology experts
- Requesting on-site demonstrations from vendors

Following the needs assessment and learning about APTS functionalities, transit managers usually developed a draft proposal for the technology for the proposal. Several case study managers hired consultants to write the technical specifications. COAST used a local technical expert. COLTS relied on the expertise of a former employee of a transit radio manufacturing company. WSTA received help from the North Carolina Department of Transportation, North Carolina State University researchers, and a consultant in writing their technical specifications.

5.5 Funding, Procurement, and Implementation

Financial resources always constrain a procurement. Thus, funding options need to be identified and evaluated. Potential funding sources are:

- State planning and capital grants
- FTA demonstration grants
- Human service agency grants
- Foundation funds
- Local private business

The case study managers were resourceful in pursuing grants and partnerships to reduce reliance on local funds. Four out of the ten received grants as federal demonstration sites (WSTA, Arrowhead Transit, Cape Cod Regional Transit Authority, and Blacksburg Transit). They also received matching state and local funds. STAR also received federal demonstration funds, then satisfied the local funds match requirement from a private business. However, the STAR project implementation stopped when the Board decided not to accept the grant award. COLTS obtained funding from a state foundation. KARTS, as part of a statewide effort, obtained state support for equipment and also a reduced local match requirement since the grouped procurement resulted in a lower cost than an individual purchase. The Mendocino Transit Authority joined procurement with five other local transit systems.

The case study transit managers did not have written implementation plan unless they were one of the four federal demonstration sites. Most managers utilized the RFP and procurement process to identify implementation steps and timeframes and they relied heavily on the vendor(s) to define detailed implementation plans in their proposals. Vendors typically defined the following implementation steps:

- Award the contract
- Determine training maintenance and upgrade needs
- Update/ Convert data bases
- Install APTS hardware and software
- Train staff
- "Go live" and test
- Begin operations

While the list is straightforward, implementation is anything but. The next section discusses implementation problems, as well as benefits.

5.6 Benefits and Problems

With the exception of the Mendocino Transit Authority, all case study sites reported varying degrees of success with the APTS technologies. Three case studies have quantified benefits and documented results in Federal Transit Administration publications and presentations (WSTA, Blacksburg Transit, STAR, and ARC Transit). WSTA's university partner North Carolina State University has written articles and papers summarizing costs and benefits. Some of the perceived benefits are as follows:

- Rapid payback on investment
- Increased vehicle productivity
- Improved passenger service, response, and safety
- Increased service area and ridership
- Improved public image
- Fewer passenger complaints
- Reduced need for vehicle supervision
- Improved vehicle schedule adherence
- More efficient schedules
- Reduced administrative paperwork

While the benefits of APTS are often listed, problems are not discussed or documented as often. The case study transit systems reported the following problems that occurred during the vision through implementation stages.

The procurement and installation processes were too lengthy. Each step in the procurement phase (RFP development, proposal review and selection, and contract negotiations) can be a cause for unexpected delays. For example, Arrowhead Transit first attempted to bundle the technologies in one procurement. Arrowhead Staff received one bid that was non-responsive to the RFP, then they reworked their procurement approach, developed separate bids for each technology, re-advertised, selected a systems integrator, and identified supporting vendors. The re-bid lengthened the implementation timeline significantly.

Unexpected delays lengthen the implementation phase. In some cases product vendors were responsible for delays and in other cases the transit staff were the cause for delay that was often not within the control of the manager. For example, at the time of initial training KARTS and COAST experienced delays due to staff illnesses. An illness of a dispatcher at COAST set back installation one year. Small urban and rural operations are very dependent on the expertise of a very limited number of key staff. CADS implementation was delayed at two case study sites because the latest version of the software was being beta-tested at another sites.

CADS, system interfaces, and other transit specific technologies are designed for urban ADA complimentary service. They require extensive customization for small city and rural systems. For example, billing is more critical for rural human service transit providers that manage human service contracts. The billing processor in CADS packages that offer this functionality is often cumbersome to set up, and utilize and calculations are difficult to validate. The Cape Cod Regional Transit Authority reported that technology vendors and the transit marketplace are not ready to supply the technologies that non-urban systems need. The Mendocino Transit Authority does not recommend CADS for small service areas that already have high productivity (even when manual systems are used). In addition, rural systems often have less in-house technical expertise than urban operations to support ongoing APTS system maintenance and updating.

Reliable computer support is difficult to find in rural areas. There may be only one local technician to several agencies. STAR reports that it can take up to three days for their local computer technician to respond due to the demand on his time.

5.7 Future APTS Plans

As presented in Section 3 (Table 3.2) significant APTS projects are in the planning stages for seen of the ten case study transit systems (ARC, Arrowhead, Blacksburg, Cape Cod, COAST, STAR, and WSTA). Of the seven plans five represent upgrades to existing APTS systems. The range of planned technologies is broad starting with CADS if not already installed and extending to AVL, MTDs, electronic fare cards and passenger information systems.

Only three of the transit systems (COLTS, KARTS, and Mendocino) have no APTS plans for the future. DARTS and Mendocino only have "entry-level" CADS and they have adoped a "wait and see" attitude toward upgrades. COLTS already is fully equiped with CADS, AVL, smartcards and voice annunicators.

The case studies have generally embraced the potential for APTS (except Mendocino) and look forward to the future.

5.8 Section Summary

The transit operators provided insight into the implementation factors that contribute to project success. Points of note include:

Build support – Transit Boards need justification to build and maintain costly hardware and software. Yet, even with Board support, a manager's effort may fail if there is change on the Board.

Anticipate delays – Prepare contingency plans for project delays resulting from staff illness, bad weather, procurement delays, technical problems, etc.

Seek professional expertise to assist with writing technical specifications – This ensures better technical specifications and therefore a higher quality response from the vendor.

Select a systems integrator – For multi-source procurement, consider hiring a systems integrator to direct other vendors and for overseeing the integration of all technologies. The single point of contact facilitates communication for the client and helps insure a quality APTS system.

Select proven products – Transit managers warn against being one of the first to use new hardware and software.

Provide training - Prepare staff with basic computer training prior to the APTS installation and invest in adequate training on the APTS technologies throughout implementation.

Section 6
Summary APTS Implementation Guidelines

The previous sections provided an overview of APTS technologies in rural and small urban areas. In addition, APTS case study experiences and a self assessment process were presented to serve as tools to the manager in selecting and implementing appropriate APTS technologies.

This final section of the report provides summary guidelines for APTS implementation. These guidelines help organize the entire APTS implementation process from assessment of services and productivity needs to technology selection, funding, procurement, and implementation. The handy checklist identifies relevant report sections for detailed information. Depending on the particular transit system and its service and productivity needs, not all steps may apply.

STEP 1: CONDUCT A NEEDS ASSESSMENT

- ❑ Identify the transit markets served (Section1, Appendix A).
- ❑ Define local system productivity and passenger service needs (Section 1, Appendix A).
- ❑ Obtain buy-in and support from the transit board and other governing bodies.
- ❑ Obtain input from key transit staff and communicate progress to staff.
- ❑ Summarize all operational and planning functions performed in-house and the manual and/or automated tools that are in use to assist with performing these functions (Section 2).
- ❑ Identify and prioritize operational functions that could be enhanced through automation (Section 2).
- ❑ Identify appropriate technologies (Section 2).
- ❑ Identify potential funding/funding sources and note their requirements (Section 5).

STEP 2: MATCH NEEDS WITH TECHNOLOGIES

- ❑ Investigate functionalities and real-life performance of desired technologies (Sections 2, 3).
- ❑ Contact technology users to obtain their perspective on product and vendor reliability, costs, etc. (Section 3, Appendix C).
- ❑ Contact vendors for product information including price list, demonstration diskette if available, and client list (Appendix B).
- ❑ Review national publications (Section 7).
- ❑ Contact "expert" consultants for their opinion (Appendices B, C, D).
- ❑ Attend a vendor workshop at a national conference or organize one at a regional level
- ❑ Evaluate technology outputs (reports, calculations, maps, etc.) and determine usefulness of data generated (Sections 2, 4, Appendix B)
- ❑ Prioritize technologies for procurement and implementation (Section 4).

STEP 3: CONSIDER COSTS AND BENEFITS

- Calculate the capital costs of alternative technologies (Section 2, Appendix B).
- Project ongoing maintenance costs for the new system (Section 2, Appendix B).
- Identify personnel resources needed and costs (Section 2, Appendix B).
- Identify other related costs (staff time/training required to implement new technologies, consultant fee to develop specifications, etc.).
- Evaluate costs vs. benefits to the public transportation system (short-term and long term)
- Identify funding sources (Section 2, Appendix A).

STEP 4: BUILD CONCENSUS

- Report findings to transit board and other governing bodies (Section 5).
- Report findings to transit staff and obtain input
- Form a review committee to be involved in:
  - Developing an implementation plan
  - Designing a procurement process
  - Developing functional specifications and RFP
  - Reviewing RFP responses
  - Selecting vendors
  - Awarding contracts
  - Overseeing installation
  - Planning for long range maintenance and system upgrades

STEP 5: DESIGN A PROCUREMENT APPROACH AND DEVELOP AN RFP

- Review procurement approach and procurement documents of other transit systems (Section 5).
- Conduct follow-up telephone interviews with transit operators that were contacted in Step 2 to learn from their mistakes in the procurement process (Section 3, Appendix C)..
- Visit transit sites that have implemented similar technologies (Section 3).
- Define a procurement approach (Section 5).
  - Determine if it is more cost effective and efficient to procure hardware/software in one procurement package vs. bidding each major component separately.
  - Consider packaging your bid with other local transit systems to secure a reduced price on hardware/software and training.
  - Consider a statewide procurement to secure a reduced price on hardware/software training and to achieve greater reporting and billing uniformity and enhance electronic communications across transit systems within a state.
  - If more than one technology is being procured consider a phased-in approach

- Draft functional specifications. Hire an expert to draft specifications if expertise is not available in-house (Section 2).
  - Transit system background information (including a detailed description of current communication systems)
  - A clear, concise statement of the problem
  - A scenario of the outcomes you anticipate as a result of the technology implementation
  - A check-list of functional features desired
- Review FTA procurement guidelines and include federal contract language.
- Draft the RFP:
  - Introduction and purpose of procurement (Sections 1, 2).
  - Proposal requirements (number of copies, procurement agency, proposal format, etc.).
  - Evaluation process (review team, timeline for review, etc.).
  - Evaluation criteria (Sections 2, 4).
  - Transit system background information.
  - Problem statement (Section 1).
  - Functional specifications (Section 2).
  - Implementation plan (Section 5).
  - Local contract terms and conditions.
  - Federal contract terms and conditions (if federal funds are used).
  - Appendices with relevant transit system statistical information, organizational information, planning documents, etc. (Appendix A).

STEP 6: PREPARE FOR IMPLEMENTATION

- Involve staff in relevant basic computer training as needed for Windows 98, databases, etc.).
- Evaluate business practices (Section 2, 4).
- Make policy and program changes.
  - Eliminate practices that are redundant.
  - Revise fare structure (if needed).
  - Update policies.
- Review and update database files (for implementation of CADS).
  - Delete customers who have not utilized the service in a year or more.
  - Ensure each customer and common destinations have a street address.
  - Prepare a list of common destinations/addresses.

STEP 7: CONDUCT PROCUREMENT AND AWARD CONTRACT

- Advertise the RFP and mail directly to vendors on mailing lists.
- Evaluate RFP responses.
  - Compare features (design table for easy comparison).
  - Distribute RFP responses to the review team.
  - Evaluate each proposal based on the evaluation criteria

- Identify the top qualifiers and schedule demonstrations of the proposed technology systems (provide system data for vendors to use in the demonstration).
- Negotiate and award contract.
  - Negotiate terms and conditions (if allowable by funding sources).
  - Finalize implementation (installation and training) schedule.
  - Develop a payment schedule (maintain 10% retainage).
  - Award contract.

Section 7
Resources

7.1 Reports and Articles

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Lave, R.E., Teal, R., and Piras, P. Software Requirements for Demand-Responsive Transit- Final Report, TCRP, August 1996.

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7.3 Internet Resources

Vendors, Transit Operators, and Agencies	URL
3M	http://www.MMM.com/
American Cellular and Paging	http://www.ameritech.com/products/wireless/
AT&T Wireless Services	http://www.attws.com/nohost/data/da.html
Canadian Marconi Company	http://www.marconi.ca/
The CDPD Forum, Inc.	http://www.cdpd.org/index.html
The Dispatcher	http://www.thecheckergroup.com/ccsi/disp.htm/
Computer Technology International	http://www.ctim.com/
CTS Software, Inc.	http://www.cts-software.com
Decision Science Inc.	http://www.dsava.com
Digital Dispatch Systems	http://www.digital-dispatch.com
Easy Lift Transportation	http://www.rain.org/~easylift
GIRO Inc.	http://www.giro.ca/
GMSI Inc.	http://www.gmsinc.com/
InStep Mobile Communications(Taxi)	http://www.instepmobile.com/
International Road Dynamics (IRD)	http://www.ird.ca
McCain Traffic Supply Engg	http://www.mccaintraffic.com/
Mentor Engg	http://www.mentoreng.com/sites.htm
MobileSoft Consulting Inc.	http://wwwmbsoft.com
Multisystems	http://www.multisystems.com
Rockwell International	http://www.rockwell.com
Trapeze	http://www.trapezesoftware.com
Trimble Navigation(MDT)	http://www.trimble.com

Other Sites

Advanced Rural Transportation Systems-Strategic Plan	http://www.its.dot.gov/rural/docs/stratpln.htm
APTA's list of software vendors	http://www.apta.com/stats/softappl/intra.htm
California PATH Database	http://sunsite.berkeley.edu/PATH/
CTAA	http://www.ctaa.org

CTAA buyer's guide	http://www.ctaa.org/bguide
CTAA Scheduling and Dispatching Software Database	http://www.ctaa.org/resource/software/
FTA	http://www.fta.dot.gov
Instep Mobile Communications	http://www.instepmobile.com/
ITS Architecture Browsing Site	http://www.odetics.com/itsarch/
ITS Web Site	http://www.its.dot.gov/
ITS Online	http://www.itsonline.com/
ITS America	http://www.itsa.org/
ITS World Home Page	http://www.itsworld.com/
LEAP-Learning From the Evaluation and Analysis of Performance	http://www.path.berkeley.edu/~leap/
OUTREACH and Escort, Inc.	http://www.outreach1.org/
TCIP	http://www.tcip.org/
Unwired Planet Wireless Internet Platform	http://www.uplanet.com
US Department of Transportation	http://www.dot.gov/
WSTA	http://www2.ncsu.edu/eos/service/ce/research/stone_res/mnsurask_res/www/wsta.html

Articles on the Web:

Agency Name	Author	Name of Article	URL
NCSU	Dr.John Stone & Michael Surasky	Internet Connections for Transit Operators	http://www2.ncsu.edu/eos/service/ce/research/stone_res/mnsurask_res/www/techbrf1.html
NCSU &ITRE	Dr.John Stone & Tahsina Ahmed	ITS Comes to Small Urban and Rural Transit Operations	http://www2.ncsu.edu/eos/service/ce/research/stone_res/mnsurask_res/www/tbr2.html
NCSU	Dr.John Stone & Vinay Karle	An Intelligent Approach to Dial-A-Ride Scheduling	http://www2.ncsu.edu/eos/service/ce/research/stone_res/mnsurask_res/www/techkbus.html
NCSU	Dr.John Stone & Shoma Chakravarty	Transit Routing and Scheduling: Computer do it better?	http://www2.ncsu.edu/eos/service/ce/research/stone_res/mnsurask_res/www/sh_tah/sim.html
NCSU	Dr.John Stone & Michael Surasky	Advanced Internet Communications for Transit Operators	http://www2.ncsu.edu/eos/service/ce/research/stone_res/mnsurask_res/www/tb6/tb6.html
CTAA		ITS and Smaller Transit	http://www.ctaa.org/its/insert1.htm
CTAA		No Respect for Rural America	http://www.ctaa.org new/clinton-bud-edit.htm
CTAA		Community Transportation and the Clinton Budget: Good News, bad News	http://www.ctaa.org/new/clinton-bud-edit2.htm
CTAA		To Strive, to Seek, to Find, and Never to Yield	http://www.ctaa.org/new/clinton-bud-ctr.htm
CTAA	Mike Henson,	The Computer Revolution Comes to Rural America But are rural transit managers ready?(December 1996)	http://www.ctaa.org/ctr/dec96/softmgr.htm

CTAA	Kelly Shawn, Chris Winters & Scott Bogren	Making New Technologies Work for Rural Transportation, Info Brief 4, May 1996	http://www.ctaa.org/resource/rtap/ib/newtech.htm
CTAA	George Rucker	Rural Transit: Stretching to Meet the Needs of the Neediest, Fact Sheet 9, January 1995	http://www.ctaa.org /resource/rtap/fs/stretch.htm
CTAA	George Rucker	Section 16 Transportation Providers: Sources of Operating Funds Fact Sheet7,November 1994	http://www.ctaa.org/ resource/rtap/fs/16funds.htm
CTAA	Laurel J. Radow & Chris Winters	Rural Transit Performance Management	http://www.ctaa.org/ resource/rtap/ta/perform2.htm
CTAA	Anna Nalevanko	Rural Transit Service Design and Scheduling, Technical Assistance Brief 12	http://www.ctaa.org/resource/rtap/fs/18-prov.htm
CTAA		Getting SMART, November 1995	http://www.ctaa.org/ctr/nov95/smart.htm
ITS		Advanced Rural Transportation Systems: (Rural ITS) Strategic Plan	http://www.its.dot.gov/rural/docs/stratpln.htm
ITS		Advanced Rural Transportation Systems	http://www.its.dot.gov/rural
FTA		APTS Benefits	http://www.fta.dot.gov/fta/library/technology/APTS/apts_ben.htm
MIT		MPO Info Tech Table	http://yerkes.mit.edu/narc/Matrix/matrix.html
AVL		AVL Information Systems, INC	http://www.brincad.com/avlis\pharspec.htm
GPS		Communication Systems International Inc. :NAVSTAR GPS and DGPS	http://www.csi-dgps.com/dgps.htm
Winsys-tems		Winsystems PC/104 J1708 Interface	http://www.winsystems.com/pj1708.htm
TCIP	Buffkin, Jia, Levin & Okunieff	Scheduling Software: Transit Communications Interface Protocols(TCIP)	http://www.tcip.org/paper4.html
TCIP	Xudong Jia, Paula Okunieff, Tom Buffkin & Jack Bailey	Integrating TCIP/NTCIP and SAE J1708/J1587,White paper 2, February 1997.	http://www.tcip.org/paper2.html

Appendix A
The National Perspective

This report focuses on the local needs small urban and rural transit operators as they acquire advanced public transportation systems (APTS) technology. Local needs, however, must also be considered within the scope of national needs and trends for public transportation. This national perspective is defined in the following paragraphs.

The Community Transportation Association of America is a national voice for the issues confronting public transportation managers, especially those in small towns and rural areas. In testimony before the Senate Committee on Banking, Housing and urban Affairs in July 1997 the CTAA answered questions regarding what areas are served (or not) by public transportation, who is using public transportation, and how equitable public transportation investments are (http://www.ctaa.org/new/testimony-72297.htm). That testimony and other cited references provide the basis for the discussion that follows.

Who is being served, or not, by public transportation?

Millions of people throughout the U.S. rely on public transportation to travel to medical and social services, jobs, education and business. In 1997 there were 1,200 rural public transportation providers, more than 200 transit systems in small towns and cities, and thousands of specialized paratransit operators such as taxis and vans serving senior centers, daycare centers, and medical agencies. Figure A1.1 shows the distribution of the U.S. counties with rural transit systems.

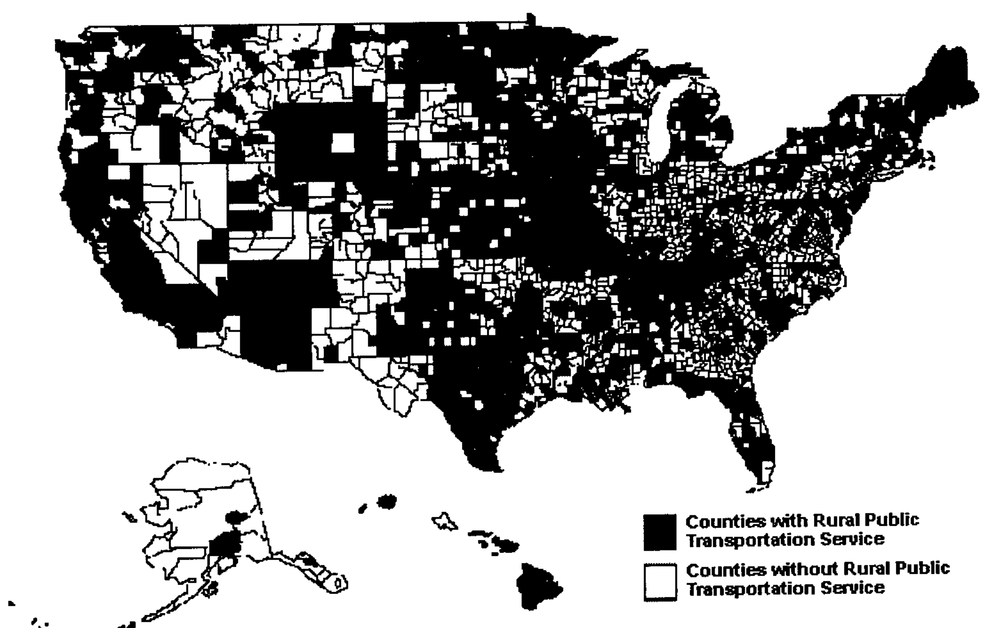

Figure A1.1: Rural Public Transportation Service in the U.S. (Source: CTAA, 1994)

Americans living in small urban and rural areas represent a significant proportion of the total population, yet they receive significantly less transportation services (1994 National Transit Database; 1994 Status Report on Public Transportation in Rural America). For comparison 132 million Americans live in large urban areas with more than 200,000 people, and nearly all have access to public transportation (Figure A1.2). Small urban areas with populations between 50,000 and 200,000 claim 26 million residents, and approximately 76 percent have access to public transportation. However, in non-urbanized and rural areas with populations less than 50,000, there are 91 million people, yet only 58 percent or 53 million people live near enough to public transportation to use it. Of those 53 million rural residents, 14 million receive less than 25 yearly trips per household (Community Solutions, Vol. 1, 1995). Figure A1.2 summarizes these three transit markets and their access to public transportation.

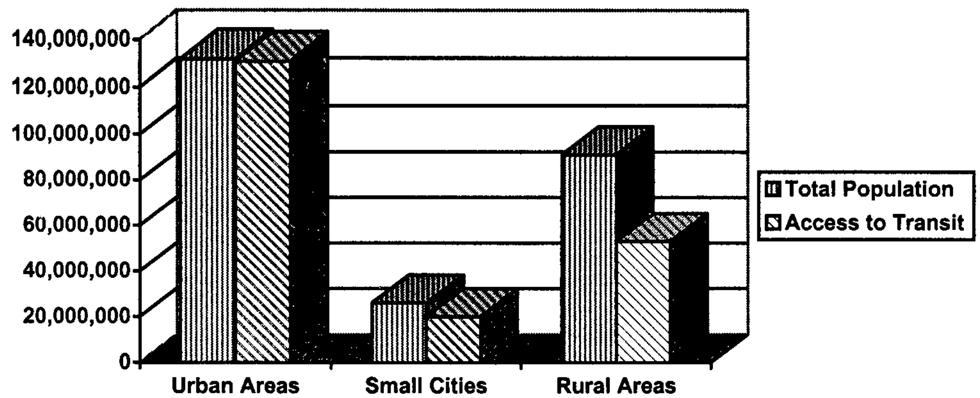

Figure A1.2: Access to Public Transportation,
Source: http://www.ctaa.org/new/testimony-72297.htm

Who is using public transportation?

Access to transit service does not mean that all people in a transit market actually use public transportation. Transit is primarily used by the transportation disadvantaged. Approximately 105 million Americans are transportation disadvantaged meaning that they are unable to provide their own transportation to jobs, health care and other daily activities (Figure A1.3; 1996 Statistical Abstract of the U.S.) Nearly all of the nation's 43.6 million elderly rely on friends, family or transit for transportation. Many of the 38 million Americans living in poverty need public transportation. Indeed 10.6 million households do not have an automobile. Approximately 2.7 million of those with no automobile live in rural areas where distance intensifies transportation needs.

Besides the traditional transportation disadvantaged groups composed of the elderly, poor and disabled, a new group has recently received major attention – the welfare-to-work group. In July 1996 the Personal Responsibility and Work Opportunity Reconciliation Act (commonly referred to as the Welfare Reform Act) redefined how poor families with children will receive financial assistance. Rather than receiving continuous Federal aid, poor families (90 percent of which are headed by single mothers) must turn to states for assistance that is usually time-limited and requires work within two or three years. In order to join the workforce, however, single mothers receiving welfare cite the unavailability of affordable childcare and the lack of reliable transportation to work as two imposing barriers. In particular when a welfare mother goes to

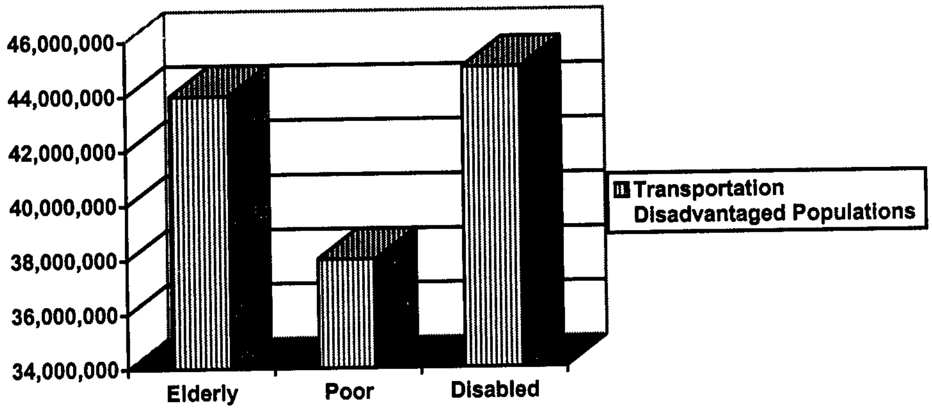

Figure A1.3: Transportation Disadvantaged
Source: http://www.ctaa.org/new/testimony-72297.htm

work her transportation costs double (Edin and Lein 1997). She usually must make intermediate stops during the work commute to drop off and pickup children at day care and to shop. 20 to 40 percent of urban welfare mothers own cars, which implies that 60 to 80 percent need transit. Unfortunately about 70 percent of the entry-level jobs for which the mothers are qualified are located in the outer suburbs of metropolitan areas that are not generally served by transit (Kasarda 1995). Thus, the work commute is complicated if not problematical for the majority of welfare mothers.

Unemployment and the need for public assistance are especially critical in rural areas and small towns where unemployment rates are higher than in metropolitan areas. Nationally, one in four families receiving public assistance lives in a rural area, and a disproportionate share of rural and small town residents live in poverty (Bogren, Community Transportation, Nov. 96). The challenge of moving welfare recipients off public assistance and into employment is exacerbated in rural areas by the scattered distribution of people, services, and jobs.

Accurately estimating the size of the welfare-to-work transit market is difficult. It will include men, women and daycare children. In 1995 4.3 million adults received Aid for Dependent Children, and of the total 3.8 million (88 percent) were women (Department of Health and Human Service 1997). Approximately 50 percent of all welfare parents have at least one child under the age of 5 who needs daycare. Consequently there are about 2 million daycare children. Thus, an extremely rough national estimate of the "latent demand" for welfare-to-work transit is the sum of the adults plus daycare children multiplied by the percentage needing transit, assuming all adults receiving public assistance found jobs. The calculation includes 6.3 million adults and daycare children multiplied by 60 to 80 percent needing transit. The result yields 3.8 to 5 million persons if all welfare parents found jobs. If each parent and child made two daily transit trips, the latent demand for welfare-to-work transit would approach 7.5 to 10 million daily passenger trips. Assuming 250 working days per year, this result translates to about 1.9 billion to 2.5 billion annual passenger trips if all welfare parents were employed. Assuming a 25% employment rate for welfare families the total drops to about 500 to 625 million annual passenger trips that are about 10 percent of the current 5 billion annual bus trips by all people

(APTA Transit Fact Book 1997). Figure A.1.4 summarizes the annual latent demand for welfare-to-work bus transit assuming different levels of welfare-to-work employment (25%, 15%, and 10%) and that 60% of the welfare-to-work adults and children are transit-dependent.

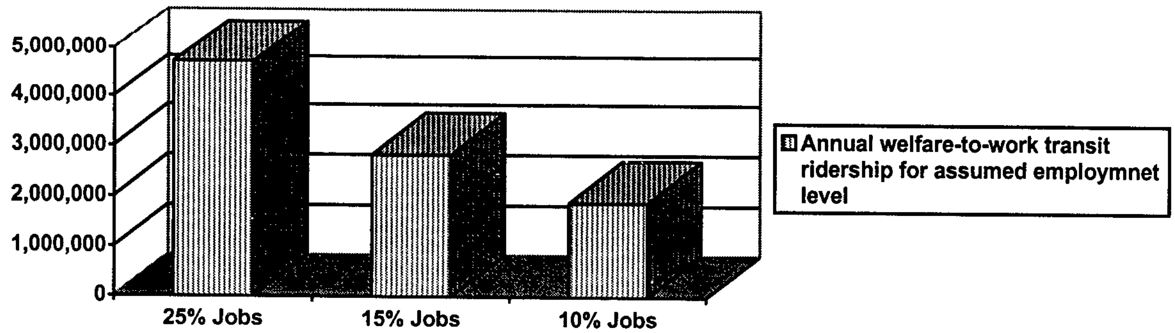

Figure A.1.4: Transit Latent Demand for Welfare-to-Work Trips

Though much smaller there is still another emerging market for public transportation in small towns and rural areas. Young professionals, especially those with families, are moving to non-urbanized areas that they find safe and peaceful. Being "upwardly mobile" themselves, they are looking for safe, convenient transportation options for their families, as well as themselves (Johnson, 1997: http://www.luc.edu/depts/sociology/research.html).

What is the ridership of public transportation?

While the previous statistics and graphs describe the need for public transportation, they do not reflect the actual demand and use. This information is available from several sources including Section 15, Section 18 (Section 5311), and the APTA Fact Book. For consistency the following definitions are used in this report. They are broader categories than the standard definitions of transit agency service areas based on population (APTA Fact Book, Table 33, File bustrips, 1997).

- Urban: 250,000 population and over
- Small urban: 50,000 to 250,000 population
- Rural: less than 50,000 population

These definitions are the commonly accepted ones that began in 1990 based on the Census. They differ slightly from definitions used by CTAA in that CTAA defines smaller urban areas as those with populations up to 200,000 people. The summary data of Figure A1.5 represents 1995 total bus passenger trips of approximately 5 billion. The numbers do not separate fixed-route from paratransit, demand-responsive trips. Urban passenger trips total about 4.4 billion, small urban 300 million, and rural 275 million. As Figure A1.6 shows, women are the majority of passengers. Elderly and disabled passengers make up smaller percentages of transit ridership.

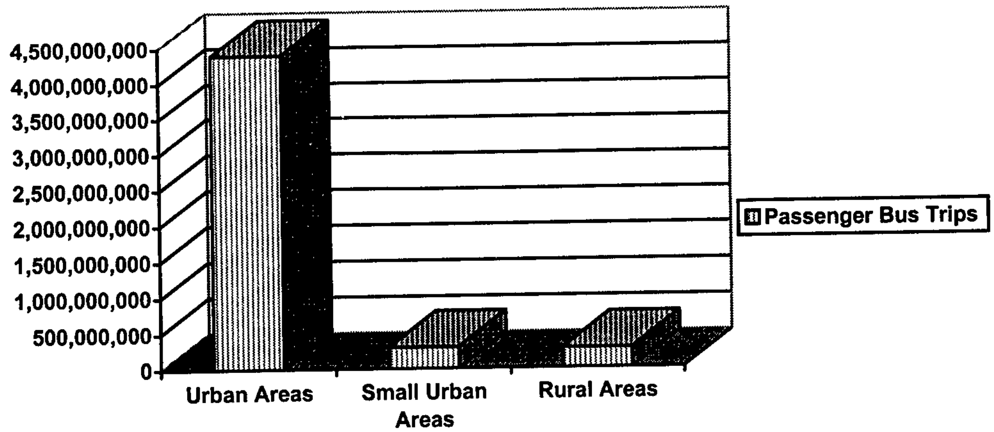

Figure A1.5: Transit Ridership (bus passenger trips)
Source: APTA Transit Fact Book, Table 33, 1997

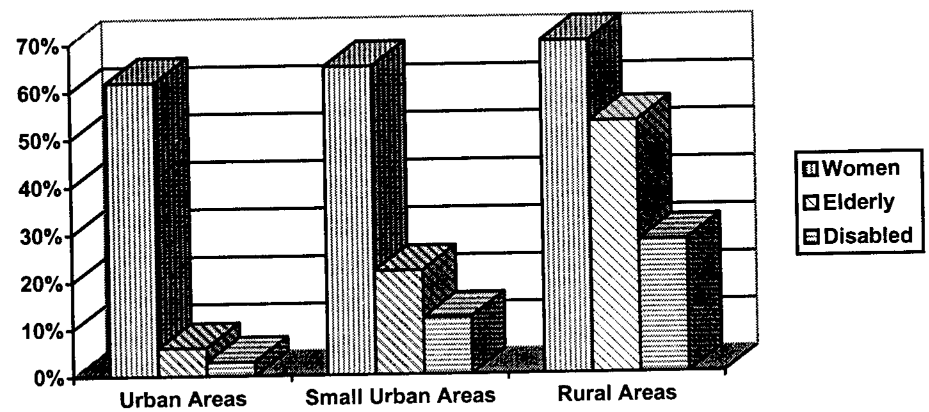

Figure A1.6: Transit Ridership Characteristics

Who benefits from transit investment?

All taxpayers fund the Mass Transit Account, yet 44 million Americans live in small cities and rural areas with no transit at all (Figure A1.2). Approximately 53 million rural residents, who represent 42 percent of the total rural population, are paying for transit service that they never see.

On a per capita basis the inequities of transit investment between large urban transit systems and small town or rural transit systems are even more apparent. According to the Federal Register of October 1, 1996, taxpayers are investing $1.64 per capita in rural areas, $10.15 per capita in small urban areas, and $27.30 per capital in urban areas. Total investments in 1996 were $187 million in rural areas, $264 million in small cities, and $3.61 billion in urban areas. Not only are small urban and rural areas receiving less transit funding, but also they are receiving significantly less relative to their populations. Figure A1.7 presents the comparisons.

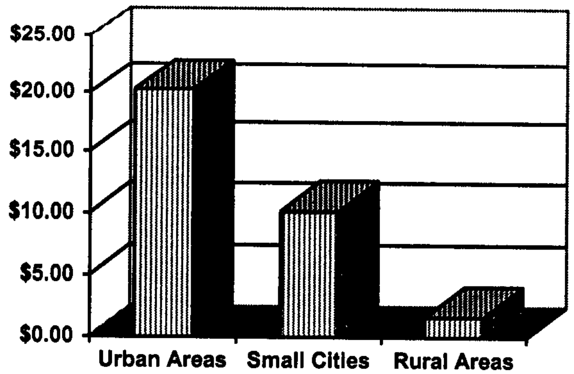

Figure A1.7: Per Capita Transit Funding
Source: http://www.ctaa.org/new/testimony-72297.htm

Figure A1.7 represents total funds including capital and operating. Of the capital funds used for transit infrastructure, federal funds can be up to 80% of the project cost. State and local governments pay the balance. However, some projects are entirely funded at the local or state level, and many areas provide more than the minimum 20% requirement. About 72% of transit operating funds come from the area in which the service is provided: 39% from passengers, 22% from local governments, and 13% from non-government sources and taxes, tolls, and fees levied directly by transit agencies. State and federal governments contribute 22% and 4%, respectively (APTA Transit Fact Book, 1997).

Is there any good news for transit in small urban and rural areas?

Is there any good news for the future given the past inequities between urban and small city/rural transit investment? Will there be better small urban and rural transit service in the future given the facts and figures of how poorly served small urban and rural areas were served in the past by public transportation? The answer to these questions is a resounding "Yes!"

The plight of small urban and rural public transportation began to change with the passage of the Intermodal Surface Transportation Efficiency Act (ISTEA) of 1991. More federal transit dollars became available to all communities, large and small. States and metropolitan areas gained flexibility to transfer funds between highway and transit programs.

The situation is even better with the reauthorization of ISTEA in a legislation called the Transportation Efficiency Act of the 21st Century (TEA-21). According to CTAA:

> This Congress has become a great friend of community transportation. That's right, appropriations for transit and transit-related federal programs are the highest they have ever been. And despite its seemingly Byzantine drama, the ISTEA reauthorization (TEA-21) debate largely features members of Congress feverishly trying to spend as much money as possible on transportation projects. The bottom line: Untold millions of dollars are becoming available that can help support community transportation.

On May 22, 1998 the House and Senate approved the massive $216 billion TEA-21. On June 9 President Clinton signed the legislation which is the largest public works legislation ever. $198 billion is guaranteed, with the remainder subject to annual appropriations. Total highway funding, including 1,800 controversial road and bridge projects, will equal about $175 billion of which $167 billion is guaranteed. Total transit funding equals about $41 billion (a 35% increase) with $36 billion guaranteed.

For rural transit operators, TEA-21 changes the long-standing funding formula, and it provides very large funding increases. The Section 5311 rural grants program increases by 32% to $177 million in FY 1999. During the life of TEA-21, rural funding will reach $240 million annually by 2003, an 80% increase from 1998 figures.

Small urban transit agencies will see Section 5307 grant funding increase by 17% to $252 million in FY 1999. Elderly and Disabilities funding (Section 5310) will increase by 8% to $67 million in FY 1999.

For comparison, the total FY transit authorization is $6.34 billion. Of that amount, $177 million goes to rural transit, $252 million to small urban transit, and $2.44 billion to urban transit (Section 5307 large urban grants). Other FY 1999 grants include: intercity bus accessibility ($8.8 million), Alaska Railroad ($4.8 million), clean fuel buses ($150 million), and major capital grants for rail and bus facilities ($2.86 billion). Other FY 1999 FTA grants total $385 million including a $150 million for access to jobs and $4.5 million for rural 5311b2 (Bogren and Zeilinger, CTAA, July 1998).

What financial impact will APTS technology have?

In most cases, application of advanced technology produces qualitative benefits such as improvements in service, efficiency, and safety. Quantitative information on the payoff of APTS technology is difficult to find, especially for small urban and rural cases. Such information is critical because it is an important factor in the APTS decision making process at the local and national levels.

FTA and FHWA officials promote the use of APTS and other types of ITS technology because of the huge national investment in technology and the proven productivity gains produced by technology in virtually all sectors of U.S. industry and commerce. Transportation professionals at FTA, FHWA and elsewhere believe that implementing APTS throughout small urban and rural systems, as well as larger systems, will produce significant gains in vehicle and staff productivities, passenger service improvements, and financial benefits.

Consider, for example, the national budget for rural and small urban transit. According to the Federal Register total transit investments in 1996 were $187 million in rural areas, $264 million in small cities and towns, and $3.61 billion in urban areas. If there were a conservative 5% national productivity gain from implementing APTS in small urban and rural systems, the equivalent savings would equal $22.6 million, or $45.2 million at 10%. These hypothetical, though realistic savings, represent between 22% and 45% of the $100 million Congress is considering for the 1997 welfare-to work transit initiative. In other words, savings from APTS could pay for a significant part of the welfare-to-work transit program.

Additional savings can result from improved passenger service in terms of less wait time and less ride time. Consider the national small urban and rural ridership of 575 million in 1995 (APTA, 1997). If each passenger averaged a 45-minute trip including wait and ride time, then a 5% improvement would translate to about 21 million hours. Assuming a wage rate of $5.50 per hour, than a 5% service gain would translate to $118 million dollars in reduced travel time. A 10% travel time reduction would generate $236 million in saved travel time.

In total the hypothetical, though, conservative 5% APTS improvement in both productivity and service would produce an equivalent $140 million savings in real dollars plus travel time. A 10% improvement would yield about $280 million.

Appendix B
Vendor Survey and Vendor Contacts

This appendix contains the survey that the study team sent to APTS software and hardware developers in order to obtain the latest features, costs and contact people regarding their products. Contact information for the developers appears in tables in this appendix. The results of the survey and follow-up telephone calls appear in Section 2. For the latest information contact the developers directly by phone, email or web site.

ITRE

Institute for Transportation Research and Education
North Carolina State University

Survey of Computer Dispatch and Related Technology Options

I. COMPANY INFORMATION

a. Company Name: ____________________

b. Name of Person Completing Survey: ____________________

c. Title of Person Completing Survey: ____________________

d. Phone: __________ e. Fax: __________ f. E-mail: __________

g. Company Address: ____________________

____

II. PRODUCT INFORMATION (If you offer more than one product, please duplicate this survey and complete it for each product.)

a. Product Type: ☐ AVL ☐ MDT ☐ Scheduling and Dispatch software
☐ Electronic Farecard Media or Equipment (Type): ____________________
☐ Other ____________________

b. Product Name: ____________________

c. Product Description: ____________________

____

____

d. Is a manual provided? ☐ Yes ☐ No
1. If yes, does the manual cover the following: ☐ Setup ☐ Training ☐ Maintenance

e. Operating System(s): ☐ DOS/Windows 3.11 ☐ Windows 95 ☐ UNIX ☐ Windows NT 3.51 ☐ Windows NT 4.2 ☐ Other ____________________

f. Target market by number of vehicles : ☐ 1-5 vehicles ☐ 6-10 vehicles ☐ 11-20 vehicles ☐ 21-30 vehicles ☐ 31-49 vehicles ☐ 50 + vehicles

g. Target market by one-way trips per day and trip type: ☐ less than 250
☐ greater than 250 with fewer than 150 demand response trips
☐ greater than 500 with fewer than 150 demand response trips
☐ greater than 500 with greater than 150 demand response trips

h. Target market by service type: ☐ Human Service Transportation ☐ ADA Paratransit

i. Date of first installation: ____________________

j. Number of public transit installation sites: ____________________

k. Has this product been interfaced with other technologies?: ☐ Yes ☐ No
1. If so, which ones? ☐ Scheduling and Dispatch Software ☐ Smart Card

☐ AVL ☐ MDT
☐ Other ______________________

III. COST INFORMATION

a. In vehicle Equipment Cost:______________________
1. Base station hardware Cost:______________________
2. Base station software cost:______________________

b. Is initial training included in product cost? ☐ Yes ☐ No
1. If yes, how many days of training are included? ______________
2. If no, how many days of training do you recommend? ______________
3. If no, what is training cost per day? ______________

c. What is the daily rate for additional, on-site training after initial training period? ________

d. Annual Maintenance Fee: ______________________

e. What does the annual maintenance fee include? ______________________
____

f. Cost of Software interface to other technologies (i.e. interface between scheduling software and MDT or AVL): ______________________

g. Please list any other related costs. ______________________

IV. SOFTWARE PRODUCTS ONLY

a. Does your product include a built in function which outputs all reports and tables to any of the following standard information exchange formats? ☐ dBASE ☐ ASCII
☐ Lotus/Excel Spreadsheets ☐ Other ______________________

b. Is outputted data in a structure such that users may manipulate data and create their own reports? ☐ Yes ☐ No

V. HARDWARE PRODUCTS ONLY

a. What communications standard does your product use to communicate with other products?
☐ SAE J1708 ☐ SAE J1587 ☐ SAE J1455 ☐ DOS/Windows 3.11
☐ Windows 95 ☐ UNIX ☐ Windows NT 3.51 ☐ Windows NT 4.2
☐ ASCII ☐ Other ______________________

b. Have you developed PC/Workstation software to manage and report on data created by your hardware? ☐ Yes ☐ No (If you answer yes here be sure to answer questions III a.1 and 2)

VI. SCHEDULING AND DISPATCH SOFTWARE ONLY

a. Does your product use GIS to geocode addresses? ☐ Yes ☐ No
1. If yes, which GIS product? ______________________

b. Does your product allow users to book trips by zones? ☐ Yes ☐ No

c. Does your product have a billing component? ☐ Yes ☐ No
1. If yes, please describe the type of billing it may be used for? ______________
____

d. Does your product produce reports on performance indicators such as rides per hour and rides per mile? ☐ Yes ☐ No
1. If yes, please describe the number and types of reports. ______________
____
____

VII. ADDITIONAL INFORMATION

We would appreciate additional information on your product such as brochures, sample diskettes, and client lists. Please send these materials to:

Aaron Frank
ITRE @ NCSU
Box 8601
Raleigh, NC 27695-8601

Thank you for contributing information to our survey. Please fax completed survey forms to Aaron Frank at 919-515-8898 by October 22, 1997.

CADS Vendors

Company Name	Company Address	City	State	Zip	Phone	Fax	Contact	Name
Advanced Transit Solutions	200 West Victoria Street	Santa Barbara	CA	93101	(800) 640-5844	(805) 882-2329	Tom	Roberts
Aegis Transp. Information System	115-45 S.W. Settle	Beaverton	OR	97005			Robert W.	Gbehnke
Aleph Computer Systems, Inc.	1700 Shattuck Ave., Ste. 1	Berkeley	CA	94709	510-843-4443	510-841-6757	Ray	
Allied Signal, Inc.	One Bendix Road	Columbia	MD	21045			Vince	Pearce
Amherst Computer Associates	RR#1 Box 286	Northfield	MA	01360	413-498-4443		Paul	McOwen
Applied Systems Institute, Inc.	1400 K Street, Ste 400	Washington	DC	20005	202-371-1600		Phillip	Lee
Argo Instruments	212 Ft. Collier Rd.	Winchester	VA	22603	(540) 665-0200/ 703-665-0200	(540) 662-212	Margaret	Schwartz
ARMATA Technologies		Tampa	FL	33609-1013			Jim E.	Scott
ATE Management & Services Co., Inc.	49 E. Fourth St., Ste. 700	Cincinnati	OH	45202	800/543-1944	(513) 38-0149	Andrew	Mundew
Automated Business Solutions, Inc.	55 State Rd.	Media	PA	19063	610/565-2800	610/565-5307	Stephen	Pelligrini
Automated Dispatch Services, Inc.	8175 N.W. 12th St., Ste. 430	Miami	FL	31126	305/471-0441	305/471-0443	David	Cohen
Bar Harbor Software, Inc.	R.R. #1, Box 192	Trenton	ME	46050	207/667-8007	207/288-5886	Ann	Lee
BDM Federal, Inc.	1501 BDM Way	McLean	VA	22102	(703) 848-6494	(703) 848-5172	Susan	Coughlin
Bellomo-McGee, Inc.	8330 Boone Blvd.	Vienna	VA	22180			Salvatore	Bellomo
BISPAC	614 Figueroa St.	Folsom	CA	95630	916/985-7009	916/985-7177	Gary	Coverdale
Bi-State Development System (BSDA)	707 North First Street	St. Louis	MO	63102	(314) 982-1433		Thomas E.	Kinealy II
BRW Inc.	700 3rd Street	Minneapolis	MN	55415			Jeffrey	Benson

CADS Vendors (cont.)								
Company Name	**Company Address**	**City**	**State**	**Zip**	**Phone**	**Fax**	**Contact**	**Name**
Computer Systems Integration, Inc.	11832 Rock Landing Dr., Ste.104	Newport News	VA	23606	801/873-0995		Al	Plotnik
Computer Technology International	P.O. Box 95624	Atlanta	GA	30347	(404) 320-7003	(404) 320-7004	Geoffrey	Berlin
CTS Software, Inc.	P.O. Box 7228	Jacksonville	NC	28401	800/704-0064	(703) 243-8627	Joe	Schwalenberg
Decision Science, Inc. (D.S.I)	912 Crain St., Unit 8	Evanston	Il	60202	(847) 864-0919	(847) 475-2021	Michael	Seef
Easy Lift Scheduling Solutions	423 W. Victoria	Santa Barbara	CA	93101	(805) 568-5179	(805) 568-5120	Tom	Roberts
EDGAR Management Consultants, Inc.	450 N. San Antonio Road Ste 49	Palo Alto	CA	94306	415/856-1184	415/856-1185	Peter	Caswell
EG&G Dynatrend, Inc.	45 William St	Wellesley	MA	02181-4004	617-272-0300	617-270-4999	Carol	Schweiger
Fleet-Net Corporation	2600 S. Rainbow Blvd. Ste 200	Las Vegas	NE	89102	(702) 873-2228	702-873-3036	Victoria	Newell
GEC-Marconi Transport System	Elstree Way	Borehamwook, Hertfordshire	England	WD6 1RX	++44/81-953-2030	++44/81-953-5262	A.	Martin
GIRO, Inc.	75 Port-Royal Street East, Ste. 500	Montreal	QB	H3L 3T1	514/383-0404	514/383-4971	Nigel	Hamer
Glenayre Digital Systems, Inc.	1590 Kootenay St.	Vancouver	Canada	V5K5B8	(604) 293-4343		Gunnar	Jonsson
Henson Consulting	RR1 Box 543	Pennington Gap	VA	24277	540/546-2530		Mike	Henson
IBM	4800 Falls of the Neuse Rd.	Raleigh	NC	27609	850-7500		David H.	Coe
Innovative Software Designs	1101 West Kennedy Blvd.	Tampa	FL	33607	800/881-0088	813-870-2998	Scott P.	Vanover
Intelitran	2000 Oxford Dr. Suite 430	Bethel Park	PA	15102	412/854-6940	412/854-6941	A.J.	Bittman
IRD Teleride	156 Front St. West 5th Floor	Toronto	Ontario Canada	M5J-2L6	(416) 596-1940 ext. 376	416-595-5653	Josef	Kates

CADS Vendors (cont.)

Company Name	Company Address	City	State	Zip	Phone	Fax	Contact Name	
JHK & ASSOCIATES, INC.ECO Tools	4660 Kenmore Avenue Ste 1100	Alexandria	VA	22304	(703) 820-5455	703-823-8347	David	Roden
JRL Associates, Inc.	8430 Brook Rd.	McLean	VA	22182	703-356-4535		Karl	Nyberg
Ketron Division	1003 Arrandale Blvd.	Exton	PA	19341	601-298-9000	610-280-9079	John	Balog
Keystone Information Systems, Inc.	1000 Lenola Road	Maple Shade	NJ	8052	(609) 722-0700	(609) 772-5871 / 609/234-5871	Bob	Ahern
KLD Associates, Inc.	300 Broadway	Huntington Station	NY	11756	516/549-9803	516/351-7190	Edward B.	Lieberman
Management Analysts, Inc.	43 Sandcastle Drive	Ormond Beach	FL	32176	904-441-4621	904-441-5199	Dr. Carl	Thornblad
Megadyne Information System	2800 28th Street, Suite 205	Santa Monica	CA	90405	(310) 452-1677		Robert A.	Chapman
Micro Dynamics Corporation	PO Box 5306	Evansville	IN	47716-5308	812/477-3090		Paul D.	Buroker
Mobile Computer Systems Inc. (MCS)	333 Jenkintown Commons	Jenkintown	PA	19046	215/886-0430	215/886-1256	Martin	Kish
MS Enterprises	225 Viscoloid Ave.	Leominster	MA	01453	(508) 537-5454		Moiz	Bhindarwala
Multisystems, Inc.	10 Fawcett St.	Cambridge	MA	02138-1110	617/864-5810	(617) 864-3521	Kurt	Dossin
Paratransit Software	21712 Brink Meadow Ln.	Germantown	MD	20876	301/540-8878	(301) 540-8878	Ed	Neigut
Paratransit Systems Int'l, Inc.	4810 Auto Center Way	Bremerton	WA	98312	360-377-7007 / 800/926-2345	360-377-6017	Aimee	Gordon
PC Solutions, Inc.	8848-CC Red Oak Blvd.	Charlotte	NC	28217	704-525-9330	704-525-9539	Jane	Scism
Phillip G. Dorcas and Associates	P.O. 161697 (1101 W. Berry)	Forth Worth	TX	76161	817/921-9704	817/921-9657	Phillip	Dorcas

CADS Vendors (cont.)

Company Name	Company Address	City	State	Zip	Phone	Fax	Contact Name	
Pin Point	4845 Pearl East Cir Ste. 301	Boulder	CO	80301-6113	(800) 474-4489	303-473-9128	David	Cohen
PRC Public Management Service	1500 PRC Drive	McLean	VA	22102	703 556 2387	703 556 2468	Ed	Rafferty
RouteLogic	1041 Wilshire Circle East	Pembroke Plains	FL	33027	954-431-7250	954-704-0056	Richard	Szymanski
Strata Gen Systems	122 N University Rd Suite 101	Spokane	WA	99206	509-921-6695	509-921-8961	John M.	Mathew
Sweet Computer Services, Inc.	P.O. Box 349 (405 Hwy., 150 N)	West Union	IA	52175	319/422-5638	319/422-5147	David	Sweet
Tidewater Consultants, Inc.	160 Newtown Road	Virginia Beach	VA	23462			J.C.	Barenti
Transportation Management Software Inc.	1401 Walnut St.	Murphysboro	IL	62966	(618) 684-2115	(618) 684-4660	Doug	Berner
Trapeze Software Group	15880 N. Greenway Hayden Loop, Building A, Suite 200	Scottsdale	AZ	85260	(602) 627-8400	(602) 627-8411	Rob	Dukes
University of Massachusetts-Lowell Computer Science Dept.	1 University Ave.	Lowell	MA	01854	508-934-3618		Patrick	Krolac

AVL Vendors

Company Name	Company Address	City	State	Zip	Phone	Fax	Contact Name	
3M Safety and Security Systems Division	3M Center, Building 225-4N-14	St. Paul	MN	55144-1000	612) 736-6284	(612) 737-1055	Kim	Christopher
Amtech Systems Corp.	17304 Preston Road, Bldg. E100	Dallas	TX	75252	972-733-6600 (800) 923-4824	972-733-6699	Ray	Navaro
Avel-Tech	33 Boston Post Road West, Suite 270	Marlborough	MA	1752	(508) 303-8464	(508) 303-8466	Dave	Bailey
Canadian Marconi Company	600 Dr. Frederick Philips Vlvd	Ville Saint-Laurent	Quebec	Canada H4M 2S9	514-748-3070	514-748-3017	Hubert	Pellerin
DINET, Inc.	2611 Temple Heights Drive	Oceanside	CA	92056	(619) 724-5355	(619) 724-6209	Dana R.	McKinzie
Harris Corporation	PO Box 5100 M/S 6B-3761	Melbourne	FL	32902	(407) 729-2643		Kate	McAfee
Navagation Data Systems, Inc. (NDS)	P.O. Box 23850	New Orleans	LA	70183	504-734-5566	504-734-5081	A. William	Marchal
Orbital Sciences	20301 Centurey Blvd	Germantown	MD	20874	301-428-5324	301-428-6466	Joan	Deoul
Rockwell International	400 Collins Rd. N.E	Cedar Rapids	IA	52498	319-295-9138	319-295-5420	David	Earnst
Transportation Management Solutions, Raytheon E-Systems	80 International Dr.	Linthicum	MD	21090-2211	(410) 850-7890	(410) 850-0347	Frannie	Sliwinski
Trimble Navigation LTD.	645 North Mary Avenue P.O. Box 3624	Sunnyvale	CA	94088-3642	408-481-2285	408-481-7744	Jim	Koblos

MDT Vendors

Company Name	Company Address	City	St	Zip	Phone	Fax	Contact Name	
ElectroCom Communications Systems	2910 Avenue F	Arlington	TX	76005-7521	(817) 695-7021 817/695-7521	817/695-3044	Pat	Terry
Glenayre Electronics	4201 Congress St., Suite 455	Charlotte	NC	28209	704-553-0038	704-553-0524	Richard	Galli
GMSI Inc.	2511 Horton Street # 102	Raleigh	NC	27607	919-785-7073	919-785-7093	Greg	Davis
Mentor Engineering	609 - 14th Street N.W. Suite 503	Calgary	AL	T2N 2A1	403-777-3760	403-777-3769	Michael	Koebel
Rockwell International	400 Collins Rd. N.E	Cedar Rapids	IA	52498	319-295-9138	319-295-5420	David	Earnst
Transportation Management Solutions, Raytheon E-Systems *	80 International Dr.	Linthicum	MD	21090-2211	(410) 850-7890	(410) 850-0347	Frannie	Sliwinski
Orbital Sciences *	20301 Centurey Blvd	Germantown	MD	20874	301-428-5324	301-428-6466	Joan	Deoul
Telxon **	3330 West Market Street, P.O. Box 5582	Arkon	OH	44334-0582	800 800-8008			
* MDT's for Equipment that Includes AVL hardware from this company								
** Ruggadized, miniature 486 PC.								

Electronic Fare Cards

Company Name	Company Address	City	St	Zip	Phone	Fax	Contact Name	
Cubic	5650 Kearny Mesa Rd.	San Diego	CA	92111	800-854-2173	619-268-5756	David	de Kozan
Mondex	320 Front St. West., 8th Floor	320 Front St. West.	Ontario, Canada	N5V3B6	416-348-5492	416-348-5639	Martyn	Cooper
ORGA Card Systems Inc		Paoli	PA		610-993-9810 x 242	610-993-8641	Mike	Shores
Racom Systems, Inc.	6080 Greenwood Plaza Blvd.	Englewood	CO	80111	(303)771-2077	(303) 771-4708	Michele	Carpino
Smart Card International	433 Silver Beach Avenue, Suite 103	Daytona Beach	FL	32118	(904) 323-0490	(904) 323-0494	Doug	Riehl
AES ProData	151 Brunel Road, Suite 18	Mississagua	Ontario, Canada	L4Z 2H6	(905) 890-2794	(905) 890-4590	Dini	Felsbourg
CDS Net					(213) 427-2000	(213) 427-1717	Sanford	Weinberg
GemPlus					(215) 654-8423	(215) 654-8922	Steven	Landau
G&D America					(703) 709-2866	(703) 471-5312	Hassan	Tavassoli

Appendix C
User Survey and Small Urban and Rural Transit Systems

This appendix contains the user survey and a list of the small urban and rural transit systems that the project team contacted (Section 3). More information on individual case study transit systems is in Appendix D.

ITRE

TRANSIT OPERATIONS GROUP
Institute for Transportation Research and Education
North Carolina State University

Survey on the Evaluation of Computer Dispatch and Related Technology Options for Small Urban & Rural Transit Operations

I. PUBLIC TRANSPORTATION SYSTEM INFORMATION

If you offer more than one service type (see b), please duplicate this survey and complete for each service.

A. System Name:__________________________________

B. Service Type:

☐ Fixed-Route ☐ ADA Complementary Paratransit ☐ Human Service Transportation ☐ ADA and Human Service

☐ Other:____________________________

C. Name of Person Completing Survey:____________________________

D. Title of Person Completing Survey:____________________________

E. Phone:______________ F. Fax: ______________ G. Email: ______________

H. System Address: __________________________________

II. PUBLIC TRANSPORTATION SYSTEM BACKGROUND

A. Service Area (square miles): ____________________________

B. Service Area Population (1995 estimate): ____________________________

C. Service Setting (please check all that apply):

☐ Urban ☐ Small Urban ☐ Suburban ☐ Rural

D. Organizational Structure (please check all that apply):

☐ Municipal System ☐ County System ☐ Multi-County System ☐ Transit Authority

1. If you answered **Transit Authority** above, what does the Authority cover?

   ☐ Single Municipality ☐ Multi-County System ☐ Single County or More than One Municipality within a County

E. Passenger Types:

☐ Children ☐ Elderly (not affiliated with human service agency)
☐ Head Start ☐ Disabled
☐ Other:____________________________

F. Service Schedule:

- ☐ Fixed Route (with a printed schedule for general public riders) ☐ Advance Reservation
- ☐ Flex Route (point or route deviated)
- ☐ Other:____

1. If you answered **Advance Reservation** above, what is the advanced reservation requirement?
   ☐ 24 hours ☐ 2 hours ☐ 1 hour ☐ 1/2 hour
   ☐ Other:____
2. If you answered **Advance Reservation**, please also estimate the percentage of trips by the following reservation type:
   a) Standing Orders or Subscription Trips _________%
   b) Demand Response _________%

G. How many one-way, unlinked passenger trips do you provide per weekday in the following service types?

1. Fixed Route __________
2. Advance Reservation __________
3. Other __________

H. What is your fleet size and average vehicle capacity for each of the following service types?

	# of Vehicles	Average Capacity
1. Fixed Route	__________	__________
2. Advance Reservation	__________	__________
3. Other	__________	__________

I. Number of employees by category:

1. Drivers __________
2. Driver Supervisors __________
3. Dispatchers __________
4. Reservationists __________
5. Schedulers __________
6. Control Room Supervisors __________
7. General Management __________

J. Other relevant characteristics:

____

____

K. For rural paratransit systems, do you provide transportation to the general public? ___ Yes ___ No

III. COMPUTER DISPATCH AND RELATED TECHNOLOGIES

Please describe on the form below computer dispatch and related technologies (AVL, MDT, Electronic Farecards, etc.) which you have implemented or are planning to implement.

Technologies Implemented	Install Date	Technologies Planned	Est. Install Date	Benefits of Technology	Problems w/ Technology	Satisf. Level 1=Low 5=High
1.	a)	b)	c)	d)	e)	f)
2.						
3.						
4.						
5.						

Additional Comments: ______________________________

IV. PROCUREMENT INFORMATION

A. How did you determine the need for each technology that you planed or implemented?

B. What sort of procurement process did you use to purchase these technologies?

C. Is there anything you would recommend doing differently in the procurement of these technologies?

D. What other technologies do you feel are worth considering?

E. What sort of ***assistance or guidance*** would most benefit you in deciding: which technologies may benefit you, how to procure them, and how to evaluate bids or proposals?

1. Which technologies may benefit you

2. How to procure them

3. How to evaluate bids/proposals

V. ADDITIONAL INFORMATION

We would appreciate additional information on your transit system's implementation of computer dispatch and related technologies. Please send these materials to:

Aaron Frank
Transit Operations Group
ITRE, NC State University
Centennial Campus
Box 8601
Raleigh, NC 27695-8601

Thank you for contributing information to our survey.

Please fax completed survey forms to Aaron Frank at 919-515-8898 by **October 8, 1997.**

System Name	City	State	Structure	Service Setting	Technologies Implemented	Technologies Planned
Aiken County Council on Aging (3rd party contractor)	Aiken	SC			Semi-automated CADS	
ARC Transit Inc. (Putnam County) (Fixed route)	Palatka	FL				AVL, Smart Cards.
ARC Transit Inc. (Putnam County) (Demand responsive)	Palatka	FL				CADS, digital odometer, credit card reader, Voice/Data on same channel
Arrowhead Transit/City of Virginia Dial-a-ride	Virginia	MN	3 county system		Fully automated CADS, AVL, MDT	
Ben Franklin Transit	Richland	WA				
Berks Area Reading Transportation Authority	Reading	PA	700 trips per day	HS +ADA	CADS FA	
Blacksburg Transit	Blacksburg	VA	City System	Small urban	Fully auto CADS, AVL, vehicle message system, traveler Info Web page	
Cape Cod Regional Transit Authority	Dennis	MA	Single County (15 towns)	Suburban + rural		AVL, MDT, CADS, smart card
Citibus	Lubbock	TX	Municipal	Small urban		
City of Napa	Napa Valley	CA	City System	Small urban & rural	AVL, w/ signal preemption	Stop annunciation
Clemson Area Transit	Clemson	SC			Fully automated CADS, AVL	
Colts	Scranton	PA	Regional System	Small urban/suburban	AVL, MDTs, SmartCards, Voice Annunciator	No immediate plans
Community Transit of Dellaware County	Folsom	PA				

System Name	City	State	Structure	Service Setting	Technologies Implemented	Technologies Planned
Cooperative Alliance for Seacoast Transportation (COAST)	Durham	NH	Two County	Small urban & rural		Fully auto CADS, GPS
CyRide	Ames	IA				
DARTS (Dakota County)	St. Paul	MN	County Wide	Suburban & rural	Fully auto CADS (cost benefit analysis)	AVL,MDT
Easy Lift Transportation	Santa Barbara	CA				
Escambia County Area Transit	Pensacola	FL	Single county	Small urban	CADS	
Greater Bridgeport Transit Authority	Bridgeport	CT	Single-county transit authority	Small urban	CADS	MDTs, Electronic Fare Cards
Indian River Council on Aging	Vero Beach	FL			Semi-auto CADS	
Kerr Area Transportation System (KARTS)	Henderson	NC	5 county, regional system	Rural	Semi-auto CADS	
Laketran	Grand River	OH		Small urban & rural	Trunked and digital radio, fully auto CADS, AVL	
Mendocino Transit Authority	Ukiah	CA				
Paratransit, Inc (operator)	Sacremento	CA			Semi-auto CADS	AVL, MDT
Pierce Transit	Tacoma	WA		Small urban & rural	CADS	
Potomac and Rappahannock Transportation Commission (PTRC)	Prince William County	VA				

System Name	City	State	Structure	Service Setting	Technologies Implemented	Technologies Planned
Potomac Rappahannock Transportation Commission (OMNI Link)	Woodbridge	VA	Transit authority		Fully auto CADS, AVL, MDT	
San Luis Obispo Regional Transit Authority (RUNABOUT)	San Luis Obispo	CA	ADA+ GP provider for 3 fixed route systems	Small urban & rural	Fully auto CADS	
SEPTA	Philadelphia	PA			Fully auto CADS	
South Tahoe Area Grand Express	South Lake Tahoe	CA	Municipal	Small urban & rural		CADS, AVL/GPS/MDT, passenger information systems
Southeast Missouri Transportation Services Inc. (SMTS)	Fredricktown	MO			Semi-auto CADS	Auto Ridesharing
Tri-County Community Council	Bonifax	FL	3-county system		CADS	
VOTRAN	South Daytona	FL				
Winston-Salem Transit Authority (WSTA) Trans-Aid	Winston-Salem	NC	Transit authority	Small urban & rural	Fully auto CADS	Fully auto CADS, AVL, MDT, smart card, passenger Information, Web site

User Contacts:

System Name	Address	City	State	Zip	Contact	Phone (email)	Fax
Blacksburg Transit	2800 Commerce St	Blacksburg	VA	24060	Debbie Sweatnum	540-961-1185 blacksburg.transit@bev.net	540-351-3142
Sweetwater County Transit Authoirty Sweetwater Transportation	1130 Billie St.			82901	Cindy Johnson	307 382-7827 startransit@msn.com	307 352-6896
COLTS	North South Road	Svranton	PA	18504	Jim Finan	570-346-2061	570-343-3819
Cooperative Alliance for Seacoast Transportation (COAST)	16 Peace Blvd.	Portsmouth	NH	03801	Steve Wells (Joe Follansbee is former director)	603-431-1922	603-431-1937
Brazos Transit System	504 E. 27th St				MargievLucas	409-778-4480	409-778-3606
Southeast Missouri Transportation Services Inc. (SMTS)	P.O. Box 679	Fredricktown	MO	63645-0679	Bill Osborne	573-783-5505 osborneb@fredericktown.k12.mo.us	573-783-7687
DARTS (Dakota County)	MDOT/ Off. of Transit, M. Stop 430, Rm. 210, 395 John Ireland Blvd	St. Paul	MN	55155	Sarah Brodt Lenz	612-296-3441 sb.lenz@dot.sttate.mn.us	612-297-7252
San Luis Obispo Regional Transit Authority (RUNABOUT)	206 Osos St. Suite 206	San Luis Obispo	CA	93401	Susan Medina	805-781-4362 ipslorra@slonet.org	805-781-1291
ATS/Advanced Transit Solutions	200 W. Victoria St.			93101	Dave Gradowski	805-568-5179 dbg@advancedtransit.com	805-882-2329
Easy Lift Transportation	423 W. Victoria St.	Santa Barbara	CA	93101	Tom Roberts	805-568-5119 troberts@rain.org	805-568-5120
Mendocino Transit Authority	241 Plant Rd.	Ukiah	CA	95482	Steve Turner	707-462-5765 stevemta@capcom.net	707-462-1760
California Assiciation for Coordinated Transportation	1713 J St. Suite 200			95814-3015	PeterSpaulding	916-446-8018 petes@calaction.org	916-446-8021
SEPTA	Septa Paratransit 1234 Market St. 4th Floor	Philadelphia	PA	19107	Rick Krejewski	215-580-7576 rkrajewski@juno.com	

Appendix D

Case Study Narratives

1. **Arrowhead Transit**
2. **COLTS**
3. **COAST**
4. **STAR**
5. **ARC**
6. **KARTS**
7. **Cape Cod Regional Transit**
8. **Blacksburg Transit**
9. **Mendocino**
10. **Winston-Salem**

Case Study #1: Arrowhead Transit

Market Segment: **Large Sparsely Populated Rural Area**
Interview Contact: **Don Mohawk, Director**

A. System Background Information

Arrowhead Transit (Arrowhead) provides human service transportation to children, the elderly, the disabled, and Head Start participants in a 20,000 square-mile multicounty rural/small urban area of Minnesota. Arrowhead contracts with ten agencies and also provides general public service. No ADA service is required because the transit system does not offer fixed-route bus service.

Arrowhead has a fleet of 52 vehicles (passenger vans) and employs 60-70 staff. Administrative staff totals 12, including 3 dispatchers. The average number of daily trips is 1,500. Arrowhead was unable to provide detail regarding the numbers of subscription trips and demand responsive trips. Prior to technology implementation, Arrowhead had five operating sites in a seven-county area. The system plans to consolidate and become the centralized dispatching center for the seven counties.

B. Technology Implemented

The technologies installed in July 1997 included:

- DRT software - Midas PT, Multisystems
- AVL - American Mobile Satellite
- MDT - American Mobile Satellite

The AVL and MDTs are operational, but the Midas PT system is not fully operational. Arrowhead is a beta-test site for Midas PT and this is the first site where this software is being interfaced with AVL and MDTs. Estimated Costs for Midas PT implementation: $107,000 for five workstations and one year of support, $88,000 for a TransCAD base map and interface, and $50,000 for hardware.

C. Needs Assessment

Arrowhead determined its technology needs through a planning process with the Minnesota Department of Transportation (MNDOT) and other stakeholders. MNDOT took a leadership role in the planning for the technologies, applying for a federal grant to be a federal demonstration site, and procuring the technologies. This was also an opportunity for MNDOT to collaborate with Arrowhead to share technology resources and personnel to improve customer service. The technology implementation initiative allowed both partners to locate transit dispatchers, DOT maintenance, and the state highway partrol in the same building. Other goals included the following:

1. Centralize call taking and dispatching functions (Arrowhead, Grand Rapids, and International Falls sites will merge first, with Arrowhead responsible for dispatching all trips).
2. Improve communications between vehicles.
3. Improve communications between centralized dispatching and the vehicles.
4. Enhance radio coverage.
5. Begin recording demand-responsive passengers (prior to implementing the technologies, Arrowhead had no mechanism to track demand-responsive passengers).
6. Provide dispatching for weekend transit service (prior to technology implementation, Arrowhead was operating some weekend trips but dispatchers did not operate on weekends).

D. Funding

The MNDOT successfully applied for a federal grant to be a technology demonstration site. The MNDOT is administering the technology implementation.To control implementation costs, the project team is gradually adding counties to the project to create a centralized operation.

E. Procurement Process

In addition to conducting a needs assessment and identifying funding sources, MNDOT and Arrowhead coordinated plans for the technologies. This involved frequent meetings of the project team. Prior to procurement, the team organized a vendor forum consisting of nine vendors to increase their knowledge of technology systems and integration issues.

A consultant was hired to write the technical specifications. The procurement document followed state guidelines and the state was the award recipient with overall responsibility for monitoring the project. Initially, the project team packaged the technologies to procure all technology systems in one bid. The initial award went to a local integrator, but the team rescinded the award after the firm lost one of its key principals. The project team pursued another round of bidding, but received no qualified bids. Consequently, the team decided to divide the single bid into three bids (during the summer of 1996) putting each of the following technologies in a separate bid: software, radio, MDTs/AVL. From the initial proposal development to award was a lengthy process, taking 2 ½ years.

F. Benefits/Problem Areas

Benefits: Although it is too early to discuss benefits, the project team anticipates that the enhanced coordination and communications arising from the technologies will increase customer satisfaction.

Problems: A significant problem was the length of the process. Arrowhead staff were anxious to implement the technologies and move forward. Arrowhead's vision of centralized dispatching required several sophisticated technologies; a more modest vision could have been achieved with less expensive and less sophisticated technologies. Scheduling software is sophisticated and not "plug-and-play". Since a user interface was not initially available for the software, Arrowhead staff required more training than was anticipated. Arrowhead planned to install the scheduling software before the other technologies in order to manage the transit system's database; however, because of the delay in developing the interface, the AVL and MDTs were implemented first.

G. Current Status

The MDTs and AVLs are operational but the full benefits of these technologies cannot be achieved until the scheduling software is operational.

H. Planned Technology Implementations

Arrowhead is evaluating options for an automated trip-booking telephone system for customers. However, Arrowhead is concerned that this technology and the three technologies already acquired have not been tested sufficiently in rural systems, despite the commonplace occurrence of these technologies in urban systems. Vendors have been very willing to modify the products to fit Arrowhead's needs.

Case Study #2: COLTS, Scranton, PA

Market Segment: **Slow or No Growth, Self Contained Communities**
Interview Contact: **Jim Finan, Director**

A. System Background Information

COLTS provides fixed-route transit in a small urban and suburban area in northeastern Pennsylvania. The service area is 164 square miles. COLTS has a fleet of 32 vehicles. The transit system's average number of annual trips is 1,899,690.

B. Technology Implemented

The technologies installed and fully operational include:

- AVL - Auto-Trac (COLTS was their first customer)
- MDTs - GMSI
- Voice Annunciator - Digital Recorders
- Bus Stop Display

Estimated Costs: $357,935 for the entire system. Since COLTS was Auto-Trac's first customer, the company was very committed to successful implementation at COLTS. The company provided 18 months of free maintenance and guaranteed response to all calls from COLTS.

C. Needs Assessment

The transit manager was familiar with the benefits of technology systems through his previous work in the rail industry. When he arrived as the transit manager of COLTS, the transit system had been receiving consistent ongoing complaints about issues such as late buses and unkempt drivers and he wanted to address these concerns.

The manager presented the benefits of technologies in addressing some of the service quality and performance issues to his board. The board had some progressive members who supported his efforts and specifically agreed to invest in the technologies to address safety issues. The two primary technology goals identified were:

- To provide better customer service by eliminating early and late arrivals.
- To improve safety for passengers and drivers in the event of an accident or a disturbance.

D. Funding

COLTS obtained funding from the Federal Transit Administration (FTA) and the state and county provided local matches.

E. Procurement Process

A consultant who is a local radio communications expert was hired to write the technical specifications. This was critical support because the transit system staff was not familiar with developing these types of functional specifications. The technologies were procured through a single bid.

Auto-Trac won the bid and the company also served as the system integrator. Thus, COLTS was able to rely on one vendor to resolve integration issues and other concerns as they surfaced.

G. Benefits/Problem Areas

Benefits:

- Improved public image
- Improved community support
- Reduced passenger complaints
- Improved adherence to vehicle schedules
- Lawsuit avoidance
- Elimination of the need for on-street supervision

Problems:

- The procurement process was too lengthy, 1 ½ to 2 years.
- Maintenance is expensive, especially for replacing electronic fareboxes. They have a $10,000/year contract (not-to-exceed) with Auto-Trac.

G. Current Status

The system is fully operational.

H. Planned Technology Implementations

No additional technologies are planned for the near term.

Case Study #3: Seacoast Transportation (COAST) Durham, NH

Market Segment: **Largely Sparsely Populated Rural Area**
Interview Contact: **Joe Follansbee, Director (left in December, 1997)**
Steven Wells, Director

A. System Background Information

COAST was established in 1981 to serve as the centralized dispatch center for the 20 human service agencies that provide public transportation services in the region (Strafford and Rockingham Counties. COAST and the agencies participate in a regional transportation coordinating council. COAST staff have taken the lead role on the council since 1994.

Coordination efforts have been slow to evolve. According to the COAST director, New Hampshire traditionally has not been supportive of coordinated public transportation. COAST has gradually assumed the responsibility for trip reservations and dispatching for the 20 participating human service agencies.

The average annual ridership: 125,000 (urban routes) and 13,239 (rural routes). Coast employs four administrative staff and ten part-time dispatchers. Each participating agency hires and oversees its own drivers.

B. Technology Implemented

The technologies installed in 1998 include:
- DRT software - Midas PT, Multisystems
- MDTs

The software is not yet fully operational. MDTs are being phased in over a one-year period. Estimated Costs: The contract for the DRT software was for five workstations at a cost of $80,000.

C. Needs Assessment

The Greater Seacoast United Way conducted a survey of Durham and the county to assess the needs of the community. The results of the survey were also used to prioritize funding for activities required to meet those needs. Transportation was identified as one of the most deficient areas and it became one of the top funding priorities.

COAST and the coordinating council that is responsible for the public transportation service were directed to evaluate service delivery and pursue options for improving service and access to service.

D. Funding

As a result of the survey, public transportation received more attention and funds became available through the state's Department of Health and Human Services to support improvements in transportation. On behalf of the coordinating council, COAST applied for funding to procure technologies that would enhance their service. The grant money would cover the cost of the initial technology (DRT software). Funding was secured in late 1996.

E. Procurement Process

Since this procurement involved state and not federal funds, COAST did not need to use a bid process. Once COAST received the grant from the state agency, it focussed on the DRT software products of two vendors: Midas received the award.

H. Benefits/Problem Areas

Benefits: It is too early to discuss benefits.

Problems: Small rural operations are very dependent on limited staff. In 1997 when COAST was preparing for installation of the DRT software, a key COAST employee became seriously ill. This delayed technology implementation for over one year.

G. Current Status

DRT software is operational. MDTs are being phased in over a one-year period.

H. Planned Technology Implementations

In the long term, COAST is interested in acquiring AVL technology (year 2,000).

Case Study #4: Sweetwater County Transit Authority (STAR) Rock Springs, WY

Market Segment: Largely Sparsely Populated Rural Area
Interview Contact: Cindy Johnson, Director

A. System Background Information

STAR offers demand-responsive contracted human service and general public service. STAR contracts with 28 agencies and operates 14 vehicles. The average annual ridership was 56,340.

B. Technology Implemented

STAR has installed the following technology:
- Semi-automated CADS software - Rides Unlimited

STAR plans to implement the following technologies:
- Fully-automated CADS
- MDTs
- AVL

C. Needs Assessment

STAR developed a plan and budget to implement APTS technologies. This plan included upgrading the software and procuring MDTs and AVL. STAR identified CADS billing/invoicing functions as key required elements to accommodate the differential billing rates requested by the client agencies. In learning more about the various technologies, the STAR manager attended a technology conference in Denver and toured the local transit system that had installed APTS technologies.

D. Funding

To purchase the SA CADS and hardware, STAR relied on Section 3 federal funding with required state and local match. The software cost was $20,000 with an additional $20,000 to $30,000 for training. To procure the other APTS technologies, STAR was awarded grants totaling $276,000 from FHWA/FTA Joint Programs Office. Because STAR was able to secure corporate contributions to serve as a local match (e.g., Novell contributed $25,000), a local government contribution was not needed.

E. Procurement Process

Not available

F. Benefits/Problem Areas

Benefits:

- STAR management reported that CADS implementation would save money, afford dispatchers with more efficient trip planning tools, enhance system-billing capabilities, and increase ridership from 5 to 6 passengers per mile.
- The STAR manager identified the importance of hiring a consultant to assist with planning and developing functional specifications. They worked with a consultant in the planning stages.

Problems:

- The STAR board voted not to accept the grant award in October 1997. The previous board that left office in July 1997 had supported the technology initiative. The board's rejection was based on a general skepticism about the effectiveness of the selected technologies and on the perception that key system personnel were inexperienced with computer technology.
- STAR anticipated that the cost of software upgrade (from SA CADS to FA CADS) would be relatively affordable, but the vendor's estimate was $78,000. It is difficult for a rural system to justify such an expense.
- The software vendor, Rides Unlimited, is no longer in business and product upgrades will not be forthcoming. In addition, product support services are prohibitively expensive for STAR's $500,000 annual budget.
- Ongoing staff training is critical to the success of CADS implementation.
- Ongoing maintenance is difficult because good computer support is in great demand in rural areas. It may take up to three days for their local vendor to respond to a request for support. The STAR manager has encouraged the vendor to consider providing support via modem.

G. Current Status

APTS implementation postponed.

H. Planned Technology Implementations

The STAR manager has initiated working with several local computer programmers to develop customized CADS software. This software is being designed for transit systems that conduct less than 3,000 trips/per day.

Case Study #5: ARC Transit

Market Segment: **Large, Sparsely Populated Rural Area**
Interview Contact: **Boyd Thompson, Director**

A. System Background Information

ARC Transit, Inc., of Palatka, Fla., is a single-county rural transit system providing advance-reservation and flex-route service to the general public. It also provides human service transportation and has contracts with ten agencies. No ADA service is required because the system does not offer fixed-route bus service. ARC has a fleet of 13 peak vehicles (passenger vans). The average number of daily trips is 470. The number of subscription trips is 320 and the number of demand responsive trips is 150.

B. Technology Implemented

All technologies are operational. The technologies installed in 1994 include:

- DRT software -(custom software)
- Electrnic Fare Cards (MagStripe Card)-
- AVL

C. Needs Assessment

Because of system abuses, the transit system was forced to install automated payroll. Automated billing was necessary to obtain more accurate data.

D. Funding

ARC obtained a funding grant in 1993.

E. Procurement Process

To procure the technologies and ensure integration with the transit system's existing technologies, ARC relied on a single vendor without using a competitive bid process (sole-source procurement). However, if the system procured the technologies again, it would bid the project as a turnkey project to firms offering standardized software and hardware packages to local operators. According to ARC staff, too much energy and funding are being wasted at the local level by systems that procure non-standardized software packages.

F. Benefits/Problem Areas

Benefits: ARC achieved the goal of automating payroll and billing.

Problems: Local development of sophisticated computer technology is a very difficult task and customization of this technology is very time consuming.

G. Current Status

The technologies are operational.

H. Planned Technology Implementations

While ARC is not considering any specific new technology at this time, it would consider implementing a technology that can facilitate accurate data transfer between the vehicles and drivers.

Case Study #6: KARTS (Kerr Area Transportation Authority)

Market Segment: **Five-County Rural Area**
Interview Contact: **Dottie Schmidt, Director**

A. System Background Information

KARTS is a multi-county transit authority that provides human service transportation to children, elderly, and all age groups of the disabled population. KARTS services a 2,102 square-mile area (estimated 1990 population of 159,544) covering five counties in north central North Carolina. KARTS provides human service transportation to more than 20 agencies and the general public. KARTS has a fleet of 51 vehicles (passenger vans with average capacity of 14 persons) and employs a staff of 36. The administrative staff consists of six employees, including two dispatchers. KARTS has 550 average trips daily and these trips are scheduled by advanced reservation. Approximately 80% of these are subscription trips and the remainder are demand-response trips.

B. Technology Implemented

KARTS installed their MiniPass system in March 1996. The MiniPass system was purchased and installed using primarily capital federal funds with a 10% local/state match. Vendor training costs and a MiniPass technical support staff person (based at ITRE) are funded by NCDOT/PTD. Software cost: $8,000. Hardware cost for 5 workstations: $30,000.

C. Needs Assessment

KARTS determined their technology needs through a planning process with NCDOT/PTD and a study committee. ITRE took a leadership role in the planning, the funding application, and procurement of the technologies. KARTS goals were to:

- Improve system organization and operation
- Provide rapid data access
- Decrease administrative paperwork
- Minimize errors
- Improve system efficiency

D. Funding

Federal capital funds with a local/state match supported hardware and software costs. The user training and a technical support person are funded by NCDOT/PTD.

E. Procurement Process

The study committee solicited local bids based on NCDOT/PTD specifications.

I. Benefits/Problem Areas

Benefits: Refer to Section C ("other goals")

Problems:
- KARTS reported problems with MiniPass program features that did not perform as advertised. The software's reporting feature was specifically identified as a problem.
- KARTS changed the architecture of an existing 486 PC to upgrade it to a Pentium equipped to run MiniPass. As a result, that computer is relatively slow and it frequently "locks up".

J. Current Status

The MiniPass system is operational. Ongoing technical assistance from ITRE is provided.

H. Planned Technology Implementations

KARTS would also consider implementing AVL, Smartcard, and High Band (trunked) two-way radio systems. To evaluate these technologies, KARTS would benefit from information workshops with hands-on demonstrations. KARTS is uncertain how they would be able to procure these technologies.

Case Study #7: Cape Cod Regional Transit Authority

Market Segment: **Rural and suburban area with significant summer tourism**
Interview Contact: **Joseph Potzka, Administrator**

A. System Background Information

Cape Cod Regional Transit Authority (CCRTA) provides transportation to the general public, children, the elderly, and the disabled in a 400 square-mile area in the Cape Cod region of Massachusetts. CCRTA also provides ADA demand-response paratransit service and they have several human service transportation contracts. The 15-town region has a year-round population of approximately 200,000 with a substantial summer tourist population. CCRTA provides fixed-route and advanced reservation service. Advanced reservations must be submitted by 11 a.m. of the previous day. Approximately 50% of the advanced reservation trips are standing order or subscription trips and the remainder are demand-response trips. CCRTA contracts with 11 different companies for their transportation services. These companies use 150-160 drivers to service the CCRTA region. Details regarding the individual transportation providers and their staffing and transportation resources were not available. CCRTA has a staff of four including an administrator, an assistant administrator, a bookkeeper, and a secretary. CCRTA provided approximately 260,000 demand-response trips last year based on a seven day per week operation schedule. Year-round fixed-route trips totaled approximately 93,000 based on a seven day per week operation schedule. A full-time summer shuttle system consisting of nine buses provided approximately 100,000 trips last year. Average weekday trip statistics were not available for any of these trip categories. CCRTA estimates that it provides an average of 110 advance reservation trips per weekday.

B. Technology Implemented

CCRTA received a $200,000 rural research grant to hire a consultant to help implement the following technologies:

- Automatic vehicle scheduling: currently re-evaluating software because the original selection was not ideally suited for rural setting (implementation by fall 1998).
- AVL: Orbital and Raytheon systems in 20 vehicles by July 1, 1998.
- MDT: plan to select and bid a system by fall 1998.
- SmartCard: plan to implement in 1999.
- Internet-based customer information system: CCRTA currently has a web page; they would like to develop a customer information system that incorporates information on all ground-based and marine-based public transportation systems on the mainland and to the islands on one Internet site.

C. Needs Assessment

CCRTA strives to maximize customer service and to use available technology to improve transit service. The administrator identified CCRTA technology needs by studying the emerging technologies that were being used by the transportation and communications industry and that could be adapted to a rural transit setting. Although the planned technologies have not yet been implemented, CCRTA has the following technology-based goals:

- Automated scheduling software – more efficient scheduling and vehicle utilization
- AVL linked to customer information system – reduce customer tension and improve satisfaction by providing the customer with estimated bus arrival times.

D. Funding

CCRTA received a $200,000 to hire a consultant to help implement technologies.

E. Procurement Process

The Administrator recommended the appropriate technologies to the CCRTA Board and the Board approved the recommendations. CCRTA worked with a consultant to develop technical specifications for the associated technologies. The consultant developed the RFP terms and conditions with assistance from CCRTA staff. The length of time required to complete the RFP packages for the automatic vehicle scheduler and the AVL was approximately three months for each product (including preliminary research and writing). Although no awards have yet been made, the RFP review/selection process is very straightforward; a three-person review team makes a recommendation to the Administrator who then makes the award. CCRTA recommends that the procurement process involve more initial study of available products before developing the RFP. Their experience indicates that the capabilities of some off-the-shelf transit products are unreliable or unsuitable for a rural setting. An internet-based clearinghouse of available technologies would be helpful. A PC Magazine-format functional analysis of available products (with cost-benefit analysis) would be very useful for transit systems trying to select appropriate technologies.

K. Benefits/Problem Areas

Benefits: The benefits of the automatic vehicle scheduling system include the following:

- More efficient scheduling and improved capacity of the existing fleet.
- Better system management potential.

The anticipated benefits of the AVL, MDT, and Internet-based customer information system include

- Improved system operation and increased customer satisfaction.

The proposed Internet-based customer information system would identify all public transportation resources in the region and help link the customer to those resources.

Problems: CCRTA suggests that technology vendors and the transit marketplace are not ready to supply the technologies that non-urban systems like CCRTA need. Many of the available technologies are suitable for the urban transit systems and do not work well in rural systems.

G. Current Status

None of these technologies has yet been implemented. The AVLs will be installed in 20 vehicles by July 1998 as part of a demonstration; after an evaluation period, the second phase of AVL installation will involve 80 additional vehicles. A neighboring RTA will receive a portion of the AVLs in the second phase. The automatic vehicle scheduler will be implemented by fall 1998. The MDT will be bid by fall 1998. The SmartCard may be implemented in 1999. CCRTA's homepage is operational, but the comprehensive Internet-based customer information system will be developed later.

H. Planned Technology Implementations

In the future CCRTA would like to implement the following technologies:

- Bus stop *estimated time of arrival* monitors.
- Comprehensive Internet-based customer information system that would track all public and private passenger carriers in the Cape Cod region (including steamships/ferries).

Case Study #8: Blacksburg Transit

Market Segment: **Rural area and university town (95% of the trips are related to the Virginia Polytechnic and State University)**

Interview Contact: **Kevin Danker, Paratransit Coordinator**

A. System Background Information

Blacksburg Transit (BT) provides transportation to the general public, children, the elderly, and the disabled in a 15 square-mile area in Blacksburg, Virginia. Approximately 95% of BT trips are for Virginia Tech students and faculty. BT also provides ADA demand-response paratransit service. BT has a fleet of 29 fixed-route buses with capacities of 30-40 passengers. Their eight demand-response vehicles have capacities of 2-20 passengers (average 16 passengers). BT employs 133 staff including: 110 drivers, 6 driver supervisors (they also dispatch), 4 part-time dispatchers, 3 paratransit reservationist/schedulers, 2 control room supervisors (dispatch supervisors), 3 maintenance personnel, and 5 general management personnel (including maintenance supervisor). BT has 9,100 average daily fixed-route trips with 95% being from the Virginia Polytechnic and State University. Advanced reservation trips average 24 per day and demand-response trips average 30 per day. Of the advanced reservation trips, standing order or subscription trips constitute 48% of the total and the remaining 52% are demand response trips.

B. Technology Implemented

BT has installed, or installation is nearly complete, for, the following technologies:

- Paratransit scheduling: Intellitrans – installation complete
- AVL: Hyperdyne (with Trimble GPS) – installation complete
- Customer information system: KIOSK, Internet homepage, dedicated cable TV channel, telephone-based system, bus stop display – KIOSK installed; remaining installations by June 1998.

- The Intellitrans, AVL system, and KIOSK are operational. The additional components of the customer information system are expected to be operational by June 1998.

The cost of AVL/GPS installation on the vehicles was $130 per bus. Each KIOSK costs approximately $4,000 to construct and equip. BT not able to provide accurate costs for the development and purchase of the other technologies.

C. Needs Assessment

BT strives to maximize customer service and satisfaction using available technology. The system identified their technology needs by studying the emerging technologies that were being used by the transportation and communications industry and that could improve BT customer satisfaction. BT viewed technology's role in enhancing their transit operation as an important benefit, but the customer's satisfaction was paramount. This was an opportunity to *develop a multi-media customer information system that would allow the customer to know the estimated time of arrival for the next bus*.

The Virginia Tech Center for Transportation Research (CTR) and BT took the lead in acquiring and implementing the AVL and customer information system technology. CTR was the general project manager for the project. The FTA and the State of Virginia provided program funding. BT identified the need for technology implementation and the other program partners concurred. Other goals:

- Intellitrans – more efficient scheduling and vehicle utilization; fewer vehicles and drivers required for the same passenger capacity
- AVL and customer information system – reduce customer tension and improve satisfaction by providing the customer with estimated bus arrival times.

D. Funding

FTA and the State of Virginia provided grants to fund the project. Hardware vendors also provided product discounts and additional technical development and assistance to create or adapt these technologies at minimum cost to the project.

E. Procurement Process

The project team consisted of the CTR, Virginia Tech engineers and scientists who were experts in each of the technologies and the required software interfaces, the FTA, and the State of Virginia. The project team met monthly for project status updates and to discuss related issues as they arose.

Individual Virginia Tech technology experts wrote the technical specifications and developed the RFP for most of the relevant technologies. BT wrote the specifications and developed the RFP for implementing a two-way radio base station. The length of time required to prepare the RFP package for each of the multiple project components or phases ranged from approximately two weeks to two months, depending on the project component involved. The procurement documents followed the Town of Blacksburg requirements, which are also compatible with the state guidelines. CTR had overall responsibility for monitoring the project.

From the initial proposal development to award, the technology development and procurement process will have taken over two years. One of the greatest challenges encountered during specification and RFP development was uncertainty about all the technical information involved in each specific project aspect. Since much of the technology involved was being developed for the project, many project details and specifications were developed accordingly.

F. Benefits/Problem Areas

Benefits: The benefits of the Intellitrans paratransit and scheduling software include the following:

- More efficient scheduling – system efficiency improved 50% with the software.
- Improved capacity with same resources – able to provide service to greater number of passengers with same number of vehicles and drivers.

The anticipated benefits of the comprehensive customer information system include the following:

- Customers will have an array of tools to obtain estimated arrival time for the next bus at each stop on the system.
- This information will help improve customer satisfaction and reduce customer stress while waiting at the bus stops.

Problems: The main problem associated with the Intellitrans paratransit and scheduling software is that the real-time automated scheduler feature does not work as well as anticipated. Therefore, BT is augmenting this feature with manual scheduling. Current problems associated with the customer information system include the following:

- A tremendous amount of programming has been required to integrate the various communication devices and associated products; most of these products were not designed to be compatible.
- Software and hardware maintenance and support beyond the development phase are issues that have not been addressed during project planning and development. Additional financial and technical resources will be required for these tasks.
- Software interface programs developed for the project have not been adequately documented to facilitate the maintenance and support phases of the project; this is especially critical because much of the associated programming was performed by graduate students who will soon be leaving the area.
- Hardware vendors have had to develop new products (and adapt existing products) for this project and this has caused delays in product implementation. Since the project is primarily a FTA experimental project, there has been no urgent financial incentive for the vendor to improve timeliness with product delivery.

For similar projects, BT recommends that the hardware and software integration issues be addressed early, before hardware selection and purchase. This would help improve the compatibility of the hardware products and decrease the need for interface programming, which was a significant portion of this project.

G. Current Status

The Intellitrans software, AVL, and customer information KIOSK are operational. The following legs of the customer information system will be integrated and operational by June 1998: bus stop display boxes, cable TV channel, telephone, and Internet homepage.

H. Planned Technology Implementations

After the current phase of technology implementation, BT would like to implement the following technologies:

- MDTs – using existing technology.
- Palm computers, instead of MDTs, to interface with Intellitrans software–using futureor undeveloped technology.
- Use Internet/intranet/extranet to perform data manipulation

Case Study #9: Mendocino Transit Authority Ukiah, California

Market Segment: **Largely Sparsely Populated Rural Area**
Interview Contact: **Steve Turner, Director**

A. System Background Information

The Mendocino Transit Authority offers demand-responsive contracted human service and general public service and fixed route service within the urban area. The service area population is approximately 15,000 in Ukiah, 6,000 at the local military site with a total county-wide estimate of 83,998. Approximately 2/3 of the service area population reside in rural areas. The number of trips is approxiamtely 393 per day on the demand-responsive service and 900 fixed route trips daily.

C. Technology Implemented

- Fully-automated CADS software - PASS

C. Needs Assessment

The Mendocino Transit Authority determined a need to streamline their dispatching and reduce their dispatching staff from 3 to 2 ½. They have dispatchers in 3 communities. They pursued CADS software because they thought this would increase their productivity, allow them to reduce staff, and streamline their paperwork. They also had a goal of efficeiently transmitting schedules via the radio.

D. Funding

The Authority used federal capital dollars to procure the software. The approximate software/hardware costs totaled $60,000.

H. Procurement Process

They went in on a procurement with six local transit authorities. Mendocino was not involved in the development of the functional specifications but joined in on the procurement just before it went out to bid.

F. Benefits/Problem Areas

Benefits: They determined that there were no long term benefits to the software.

Problems:

- Productivity decreased
- Could not achieve goal of reducing dispatch staff
- Lack of confidence in schedule functionality. Once a trip was assigned to a driver this was never reconsidered or reoptimized within the program
- Increased costs (project that the total cost with added personnel time during the implementation phase was three times greater than the software/hardware cost of $60,000
- No billing component (at the time of their purchase)
- Software was not optimized for a small community
- Limited capability for editing

- Lack of responsiveness of vendor

Mendocino Transit Authority staff recommend the following:

- Procure hardware and software from the same vendor
- Procurement should be based on goals and objectives – what the system wants to accomplish
- Put in financial incentives into a vendor contract – if goals and objectives are not met then vendor does not get paid

G. Current Status

The Mendocino Transit Authority decided not to continue use of the CADS.

H. Planned Technology Implementations

None.

Case Study #10: Winston-Salem Transit Authority - Trans-AID:

Market Segment: Self Contained High Growth Rural Communities

A. System Background Information

Winston-Salem Transit Authority (WSTA) is part of the Winston-Salem Department of Transportation and is responsible for the paratransit service, called Trans-AID. It is the coordinated provider of public transportation for the area. The service area is characterized as 75% urban and 25% rural. Trans-AID offers urban demand-responsive trips to Winston-Salem and rural trips to Forsyth County. WSTA also coordinates shared ride, van pooling and car pooling for three counties and provides fixed-route bus service to Winston-Salem. Three types of trips are being taken care of by PASS at present. These are subscription trips, demand responsive and will calls. Trans-AID, has a fleet of 19 small buses. Almost 80% of the annual demand-responsive Trans-AID passenger trips were recurring subscriptions needing no telephone reservation. Now more than 10% trips are demand responsive. It served about 120,000 demand responsive passengers each year. It is observed that there can be a scale effect or an indirect payoff in the rural service by using APTS in the urban system.

B. Technology Implemented

The computer-aided dispatch and scheduling (CADS) system was implemented for 19 vehicles in August 1994. At first three of the 19 vehicles carried mobile data terminals (MDTs), automatic vehicle location (AVL), smart card readers and odometer readers. Starting in 1999 WSTA will extend and upgrade all CADS and complementary hardware for the 19 buses and extend APTS to the fixed-route system. Special attention will be given to passenger communications with the central dispatch.

- Fully automated CADS software - Paratransit Automated Scheduling System (PASS)
- AVL - tested on three vehicles
- MDT - Mentor Engineering
- Smart Cards - tested on three vehicles

WSTA paid approximately $100,000 for installing CADS. The payback period is estimated to be 16 months assuming a five-year amortization period and that the reduced per passenger operating costs before and after CADS installation resulted from CADS.

C. Needs Assessment

WSTA felt the need for improvements in transportation services for elderly and disabled who need to visit health and human services. Before the installation of APTS, there was longer passenger wait time, unknown location of vehicles, virtually no rural service, poor reporting and billing, low productivity, inefficient scheduling of trips (almost no real time insertions), lack of coordination among multiple providers, over worked staff etc.

D. Funding

Funding for the APTS systems came from the NCDOT, FTA and the City of Winston-Salem. Significant contributions of professional time, in-kind services, professional time, and hardware discounts came from the software vendor and North Carolina State University.

E. Procurement Process

WSTA hired North Carolina State University to help develop an RFQ and functional specifications for the RFP. Subsequently NCSU helped WSTA to evaluate the vendor responses. The City of Winston-Salem carried out the details of the procurement and negotiations.

F. Benefits/Problem Areas

Benefits: After installation of APTS the following benefits were observed.

- The pickup window changed from 30 minutes to 20 minutes. Both cost and services have increased for the system
- 236% increase in rural passengers to 40 daily passengers
- Vehicle-miles increased 8.5%
- Vehicle-hours decreased 5.6%
- 12% increase in urban passenger trips to 513 daily passengers

G. Current Status

The system is fully operational.

H. Planned Technology Implementations

A major upgrade will occur in 1999.