INVENTORY & ANALYSIS OF ADVANCED PUBLIC TRANSPORTATION SYSTEMS IN FLORIDA

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16. Abstract

Through its National Center for Transit Research, and under contract with the Florida Department of Transportation, the Center for Urban Transportation Research has conducted an inventory of current and planned Advanced Public Transportation Systems (APTS) in Florida to help the Florida Department of Transportation (FDOT) develop baseline information on Intelligent Transportation Systems (ITS) transit activities around the state. Although the primary task of this effort was to develop an inventory of current and planned Florida APTS projects based on the results of a survey of Florida transit properties, the project also included two supplementary tasks related to the implementation of APTS technologies. One of these tasks involved examining, through a literature review, 10 of the major issues that transit properties around the country have encountered during the development and/or deployment phases of their projects, and then analyzing the Florida properties' experiences with these issues based on their survey responses. The other, and final, task involved conducting an assessment of APTS benefits for a few selected transit agencies utilizing a benefits analysis spreadsheet tool (i.e., SCRITS) and documenting the results of the assessments in order to provide an evaluation example for other agencies to follow as they continue to develop and deploy APTS technologies. It is anticipated that this research will help provide further guidance to Florida and other U.S. transit properties in the formative stages of APTS investigation.

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EXECUTIVE SUMMARY

One element of the U.S. Department of Transportation's initiative on Intelligent Transportation Systems (ITS) is the Federal Transit Administration's Advanced Public Transportation Systems (APTS) program. This program was established to encourage the use of technology to improve the quality and usefulness of public transportation and ridesharing services. The Center for Urban Transportation Research (CUTR) at the University of South Florida in Tampa has conducted an inventory and analysis of APTS in Florida to help the Florida Department of Transportation (FDOT) develop baseline information on ITS transit activities around the state. This effort was comprised of three primary tasks: (1) the development of an inventory of current and planned Florida APTS projects; (2) a literature review-based examination of 10 of the major issues/characteristics that transit properties around the country have encountered during the development and/or deployment phases of their APTS projects, supplemented by a review of the Florida properties' experiences with these same issues; and (3) the completion of an assessment of APTS benefits for a selection of case study transit agencies utilizing a benefits analysis spreadsheet tool in order to document an evaluation example for other agencies to follow as they continue to develop and deploy APTS technologies.

APTS in Florida

The first task utilized several surveys and stakeholder meetings to develop an inventory of the APTS activities going on around the state and compile the thoughts and comments of transit agency personnel and various statewide stakeholders regarding APTS in Florida. Thirty Florida transit agencies that receive or will be receiving FDOT block grant funding were identified with the assistance of FDOT's Public Transportation Office for inclusion in the study. A mail-back inventory questionnaire was sent to these transit agencies. The inventory questionnaire asked the transit agencies about five main technology areas in APTS, including: fleet management, traveler information, electronic fare payment, transportation demand management, and technologies associated with paratransit providers. Nineteen out the 30 transit agencies responded to the questionnaire.

According to the results of this initial survey, 11 of the 18 individual technologies listed in the questionnaire were still in the planning stages for many of the transit agencies at the time of the survey. Automated paratransit and advanced communications were the most popular technologies, with 14 transit agencies either in the planning, implementation, or fully operational stage. In addition, transit agencies have deployed advanced communication technologies more than any other technology mentioned.

Subsequently, a follow-up questionnaire was administered via telephone and e-mail to all of the transit agencies. Ten of the agencies participated in this follow-up survey effort. According to the results of this particular survey, the majority of the respondents expect a "very high" level of efficiency from APTS. Funding was mentioned as the primary impediment to the deployment of APTS. All of the respondents stated that it is "very important" to provide funds for APTS in public transportation projects.

For the discussion meetings that were held, CUTR invited a number of persons from around the state with a "stake" in the implementation and deployment of APTS in Florida. The stakeholders consisted mostly of FDOT senior management staff makers such as the District Directors of Operations, District Directors of Planning and Programming, and District Public Transportation Managers. According to the information exchange that took place at these meetings, most of the stakeholders were enthusiastic to receive more information about ITS architecture and the ITS Strategic Plan. In discussing the concept of ITS architecture, all respondents indicated a belief that it is important for a regional ITS architecture to conform to the national ITS architecture. All of the stakeholders also believe that APTS has the potential to improve transit operations.

In addition to the aforementioned surveys and stakeholder meetings, a survey also was conducted to gain insight from rural transit providers. According to a number of Community Transportation Coordinators in the state, some of the APTS technologies are expected to be tremendously beneficial to rural transit, especially in helping to better connect these services to the fixed-route services operating in urban areas. To provide some additional details about the APTS experiences of the rural transit providers, a general review of the Rural Florida ITS Demonstration Project being sponsored by the Federal Transit Administration (FTA) also was completed.

APTS Implementation Issues & Characteristics

The second task of the project utilized a review of available literature to provide a variety of information on 10 specific issues (including ITS Architecture & Conformity, Funding, Institutional Arrangements, Procurement, and Public Involvement, among others) related to the development and/or deployment of APTS. It also sought to document the experiences that a number of Florida transit systems have had with these same issues, based on the results of the follow-up APTS inventory survey and the stakeholder meetings.

From the literature review, it is evident that the decision to utilize a particular ITS technology is only the first step of an extensive, and often challenging, process that runs from development, to deployment, and finally to the operation and maintenance of the chosen technology. Therefore, a lot of planning and forethought must go into the development and implementation of any ITS technology. Agencies considering the deployment of a technology first will want to understand the National ITS Architecture (or any state or local architecture that has been established) and use it as a guideline during the process. If partnering is desired, it also would be prudent for an agency to understand the issues involved with various institutional arrangements. Identifying and enlisting a wide range of stakeholders in the project also will be advantageous to its success, as will ensuring that the implementation plan clearly establishes the stakeholders' roles and responsibilities, and allows for and encourages interagency coordination.

Like most other transit projects, funding will be an important issue in the process to implement ITS. Capital funding will be needed for the acquisition and installation of equipment and supporting software applications. However, most challenging to many transit agencies will be finding the funds that will be required to upkeep and operate the ITS technologies on a day-to-day basis. Operation and maintenance of the equipment will depend on the appropriate allocation of staff for those tasks. Staff also will be needed to deal with the timely and regular retrieval, analysis, and use of the resulting information from the operation of APTS. It is only through the appropriate levels of funding and staff resources that the full benefit of any ITS technology application will be reached.

Similarly, procurement of an ITS technology can also be a complicated step in the process because ITS proposals are not well served by traditional procurement practices. The complexity of most technologies and the need to adapt to constantly evolving applications require that procurement procedures be much more flexible in nature. These more adaptive procedures will help agencies be able to better account for desired goals, such as interoperability and the ability to be integrated with other technologies in the future, when procuring an ITS technology.

A key element of many of the ITS projects that have been successfully implemented around the country is the awareness and involvement of public officials and the general public. Unfortunately, general understanding of ITS and its benefits is still quite low among decision makers and the public. Since these constituencies play an important role in setting policy and establishing funding priorities, it is in the best interest of agencies implementing ITS technologies to ensure that they are made aware of ITS solutions to transportation problems and other issues. If politicians and the public understand the benefits of ITS and how it can help solve existing problems, they will be more supportive of efforts to implement these technologies.

As more people understand ITS and how it can help solve real-world issues, it will be easier to promote the more widespread implementation of ITS technologies. Eventually, it will be possible to plan for deployment that will integrate services and systems across a region, thereby ensuring seamless coverage and interoperability. In terms of mobility, transportation management centers can be established that will utilize advanced ITS technologies to provide transportation information, as well as manage and control transportation networks, on a regional basis. Ultimately, ITS will facilitate the seamless integration of transit into the statewide transportation network.

This regional outlook for the implementation of ITS technologies includes rural areas and the demand-response services that are utilized in those areas, as well. ITS technologies such as AVL and CAD have been utilized successfully for rural applications, and have benefitted rural transit providers by helping to improve the efficiency of demand-response service scheduling and operation. It is also anticipated that technology implementation also will help improve interagency coordination of services. In fact, this is one of the specific goals of the Rural Florida ITS demonstration project, which was begun in 1998.

Finally, one of the greatest hurdles that agencies will need to overcome when implementing ITS technologies is the justification of the costs in comparison to other potential improvements. This is why benefits analysis and performance measurement are critical to this process. Prior to deployment, it will be important to understand the potential benefits of the technology under consideration and demonstrate those benefits to the decision makers and all stakeholders. Performance monitoring becomes crucial during the operational testing phase of the deployment to make sure that the system is working as planned. After that, continued monitoring of performance is necessary to ensure that all facets of the system continue to operate properly. Benefits analysis then objectively compares the results of the performance monitoring with the direct and indirect costs of system implementation and, hopefully, justifies need for that technology. In addition, it will be important for agencies to share the results of their analyses with others contemplating implementation. Unfortunately, the lack of qualitative and quantitative measurements of ITS technology benefits has been found to be one of the most notable hindrances to greater ITS deployment to date, especially for transit purposes.

APTS Benefits Assessment & Performance Monitoring

The third task of this project conducted an assessment of the annual time savings benefits that five case study transit systems have accrued for their respective passengers through the implementation of one or more of three different APTS technologies: electronic fare collection, AVL, and bus priority. The spreadsheet-based, sketch-level analysis tool, SCRITS (**Scr**eening Analysis for **ITS**), was utilized to conduct each system's analysis, which examined pre- and post-deployment conditions for each technology being used, or soon to be utilized, by each system. Table ES-1 presents selected post-deployment results for the three case study transit systems that already have implemented electronic fare collection systems on-board their vehicles.

Table ES-1
SCRITS Electronic Fare Collection Worksheet Analysis: Comparison of Post-Deployment Results[1]

Transit System	Annual Value of Time Savings	Benefit/Cost Ratio
Pinellas Suncoast Transit Authority	$2,716,732	6.9
Hillsborough Area Regional Transit Authority	$1,618,087	7.2
LYNX Transit (Orlando)	$2,136,976	13.4
Average	$2,157,265	9.2

[1] All of the information presented in this table is for the "full week" case.
[2] Two case study systems, Sarasota County Area Transit and Ann Arbor Transit Authority, have not implemented the use of electronic fare media yet; therefore, their post-implementation results have not been included herein.

In addition, the topic of post-deployment performance measurement and monitoring also was introduced. The development of performance measurements for APTS technologies is extremely important because such measures enable an agency to assess how a particular technology is functioning and whether established system goals and objectives have been met by its deployment. This discussion also provided some examples of, and general recommendations for, performance measures that are applicable to the more common goals and objectives and identified specific APTS applications that may be used to achieve the objectives.

From the overall benefits analysis process, it was learned that, despite the relative simplicity of SCRITS compared to other similar analysis tools, it is still somewhat difficult to understand – especially some of the required user inputs for each of its technology worksheets. Other drawbacks of this analysis tool are that the number of APTS-specific technologies it is designed to evaluate is extremely limited, and it can only estimate the time savings benefits that accrue to a transit agency's passengers, and not any of the potential benefits that might be realized by the agency, itself. Nevertheless, the SCRITS tool is readily available, is free of charge, and is a decided step in the right direction of establishing a standardized benefits analysis process that is easily transferable between systems, regardless of size or operating environment/characteristics. Additionally, it produces results that can be understood and compared across technologies and/or agencies.

The individual system analyses also provided interesting insights, as well. For the most part, the analyses found that the majority of the APTS deployments at the case study systems have indeed benefitted passengers of those agencies in terms of annual time savings. The resulting benefit-to-cost ratios also have been positive. Unfortunately, the analyses also helped identify a number of issues at the systems related to data collection and information availability, the estimation of user inputs for the SCRITS analysis, lack of experience with APTS technologies, and concern about comparability of analysis results across systems.

Despite the issues, however, based on the research experience with the case study transit systems, it would appear that personnel at the systems are aware of the importance of benefits assessment and measuring the performance of APTS technologies. They understand the need for establishing verifiable benefits related to APTS deployment so that this information can be used to help sell their systems' potential future APTS applications to their boards, local officials, and stakeholders. Being able to demonstrate positive performance of existing technologies will help in this regard, as well. In addition, the transit industry, itself, will be well served by the additional APTS evaluation information that will be available to be shared.

INVENTORY & ANALYSIS OF ADVANCED PUBLIC TRANSPORTATION SYSTEMS IN FLORIDA

BACKGROUND

The Federal Transit Administration (FTA) created the Advanced Public Transportation Systems (APTS) program as part of the U.S. Department of Transportation's initiative on Intelligent Transportation Systems (ITS). The APTS program was established to encourage the use of technology to improve the quality and usefulness of public transportation and ridesharing services. It is believed that the implementation of various applicable technologies on transit will not only help transit systems improve the efficiency and effectiveness with which they provide service, but, because of these improvements, may also help to make transit more attractive to new users, such as the discretionary rider, as well. Persons interested in obtaining the most current information on the status of developments and advancements in the adoption of new technology in public transportation services in North America should refer to FTA's document, *Advanced Public Transportation Systems: The State of the Art, Update '98*.

The 1999 Florida ITS Strategic Plan was developed to guide the Florida Department of Transportation (FDOT), Florida Metropolitan Planning Organizations, and local governments in the planning, programming, and implementation of integrated multi-modal ITS elements to help maximize the safety and efficiency of Florida's Transportation System. A major provision of the ITS Strategic Plan is that the FDOT will pro-actively support the development, coordination, and deployment of public transportation ITS technology. However, it became apparent during the development of the ITS Strategic Plan that there was no comprehensive information at the state level regarding the location and operability of APTS in Florida. This is because much of the current APTS activity in Florida has been initiated and implemented at the local level. As a result, this study was initiated with the goal of providing FDOT with the baseline information that it will need as it becomes more involved in the development and deployment of APTS throughout Florida. Secondarily, it is anticipated that this study will provide some level of guidance to Florida and other U.S. transit properties in the formative stages of APTS investigation.

This inventory and analysis of APTS in Florida is, thus, designed to help the FDOT gain a better understanding of the current ITS transit activities being undertaken around the state. The project is comprised of three primary tasks: (1) develop an inventory of current and planned Florida APTS projects; (2) through a literature review, examine 10 of the major issues/characteristics that transit properties around the country have encountered during the development and/or deployment phases of their projects, and review the Florida properties' experiences with these issues; and (3) complete and document an assessment of APTS benefits for a few selected transit agencies utilizing a benefits analysis spreadsheet tool in order to provide an evaluation example for other agencies to follow as they continue to develop and deploy APTS technologies.

The resulting information relating to the characteristics of APTS development and deployment should be especially useful to transit properties and decision makers throughout the state and across the country. The development and deployment characteristics of APTS that this study will consider include:

- level of conformity with national (and soon to be developed Florida) ITS architecture;
- institutional arrangements needed for multi-modal and inter-modal connectivity;
- available funding sources;
- procurement methods of APTS products and services;
- impacts on agency operation, maintenance staffs, and budgets;
- extent of public-private and public-public partnering;
- extent of general public involvement;
- integration into regional transportation services and systems;
- application to rural areas and/or demand responsive service; and
- extent and sophistication of benefits analysis (prior to deployment) and performance monitoring (following deployment).

It is important to note that the terms "APTS" and "ITS-transit" are used interchangeably throughout this document. Also, in those sections where survey results are discussed, direct quotes have been included in their original form.

CHAPTER ONE

INVENTORY OF ADVANCED PUBLIC TRANSPORTATION SYSTEMS IN FLORIDA

INTRODUCTION

This chapter describes the development of a statewide APTS activities inventory and outlines the extent to which new technologies have been adopted within the public transportation industry in Florida. The primary data collection effort that was utilized to compile the information for the APTS inventory consisted of two separate transit agency surveys, a series of stakeholder meetings, and a rural stakeholder survey. The results of the surveys and the stakeholder meetings are discussed herein. In addition, information on the Rural Florida Intelligent Transportation Systems demonstration project is also included to provide the perspective of those who have already applied ITS-transit technology to their transit systems.

It should be noted that the two transit agency surveys were administered only to transit officials. The stakeholder interviews were held with FDOT senior management staff primarily. In addition, the rural stakeholder survey was administered to Community Transportation Coordinators throughout the State with the assistance of the Commission for the Transportation Disadvantaged.

INITIAL APTS INVENTORY SURVEY

In conjunction with the FDOT Public Transportation Office (PTO), it was determined that the Florida transit agencies that receive or will be receiving FDOT block grant funding should be surveyed with respect to APTS development/deployment. The PTO provided assistance in identifying these transit agencies, as well. A total of thirty transit agencies were included in the initial survey effort, which involved a mail-out/mail-back methodology. The inventory questionnaire that was developed for this task asked the transit agencies whether they were currently utilizing or planned to utilize in the future any of a number of APTS technologies. The various technologies that were included were grouped into five main APTS technology areas: fleet management, traveler information, electronic fare payment, transportation demand management, and technologies associated with paratransit providers. Nineteen out the 30 transit agencies responded to the questionnaire, resulting in a response rate of approximately 63 percent.

Table 1, on the following page, presents the thirty Florida transit properties that were selected for the survey, their system acronyms or abbreviated system names that will be used throughout the rest of this document whenever the systems are referenced, and their level of participation in the two surveys that were completed for this task. (The second survey involved a follow-up telephone interview that attempted to gather additional information on the systems' experiences with APTS development and deployment and is discussed further in a subsequent section of this document.) It should be noted that a number of the systems that did not participate in the surveys are not currently utilizing or planning to utilize any APTS technologies at this time.

Table 1-1
Florida Transit Agency Survey Participation

Transit Agency	Acronym or Abbreviation	Initial Inventory Survey	Follow-Up Survey
Broward County Mass Transit Division	BCT		
Charlotte County Dial-A-Ride	Charlotte	●	
Collier County Transit	Collier	●	●
Community Services (Stuart)	Stuart		
Council on Aging of Martin County, Inc.	Martin	●	●
County of Volusia dba VOTRAN	VOTRAN		
Escambia County Area Transit	ECAT	●	●
Hillsborough Area Regional Transit Authority	HART	●	
Jacksonville Transportation Authority	JTA	●	
Key West Department of Transportation	KWDOT		
Lakeland Area Mass Transit District (Citrus Connection)	LAMTD	●	
Lee County Transit	LeeTran		
LYNX Transit (Orlando)	LYNX		
Manatee County Area Transit	MCAT		
Miami-Dade Transit Agency	MDTA	●	
Okaloosa County Coordinated Transportation, Inc.	Okaloosa		
Palm Beach County Transportation Agency	Palm Tran	●	●
Panama City Urbanized Area Metropolitan Planning Organization	Panama City		
Pasco County Public Transportation	PCPT	●	
Pinellas Suncoast Transit Authority	PSTA	●	
Polk County Transportation System	Polk	●	●
Regional Transit Organization, Commuter Assistance Program (Ft. Lauderdale)	RTO/CAP	●	●
Regional Transit System (Gainesville)	RTS	●	
Sarasota County Area Transit	SCAT (Sarasota)	●	●
Space Coast Area Transit (Brevard County)	SCAT (Brevard)	●	●
St. Lucie County Council on Aging-Community Transit	St. Lucie		
SunTran (Ocala)	SunTran	●	●
Tallahassee Transit	TALTRAN	●	●
Trans-Hernando/Mid-Florida Transit (Brooksville)	Trans-Hernando	●	
Tri-County Commuter Rail Authority	Tri-Rail		

Inventory Survey Questionnaire

The questionnaire was organized in accordance with FTA's Advanced Public Transportation Systems program. Technologies and applications were grouped under five categories:

I. Fleet management
II. Traveler information
III. Electronic fare payment
IV. Transportation demand management
V. Paratransit providers

The status of each technology that is being tested, planned, implemented, or fully operated was requested. Appendix A includes a copy of the actual questionnaire.

I. Fleet Management

Fleet management incorporates many of the vehicle-based APTS technologies for more effective vehicle and fleet planning, scheduling, and operations. Fleet management focuses on the vehicle. It can improve the efficiency and effectiveness of the service that is being provided and can increase passenger safety, as well. The technologies that were listed in the questionnaire are:

- ☐ Automated Vehicle Location (AVL) systems,
- ☐ Automatic passenger counters,
- ☐ Vehicle component monitoring systems,
- ☐ Automated operations software, and
- ☐ On-board safety systems.

Automated Vehicle Location, computer-based, vehicle-tracking systems, operate by measuring the actual real-time position of each vehicle and relaying the information to a central location. The transit agencies were asked to indicate which technologies related to AVL they were planning, testing, implementing, or operating, such as:

- Global positioning,
- Signpost/odometer,
- Dead-reckoning, and
- Loran-C.

Automatic passenger counters are automated means for collecting data on passenger boardings and alightings by time and location. Some of the technologies that exist in the market are:

- Infra-red beams,
- Treadle mats,
- Infra-red optic sensors, and
- Ultrasonic frequency sensors.

Vehicle component monitoring systems perform periodic "health checks" of the transit vehicles. Transit agencies were requested to provide information on any systems that they were planning, testing, implementing, or operating to help monitor:

- High engine temperature,
- Low pressure oil, and/or
- Other vehicle components/conditions.

Automated operations software has the capability to automate, streamline, and integrate many transit functions and modes. Transit agencies were asked to offer information about computer applications, such as:

- Computer-aided dispatch,
- Vehicle performance,
- Driver performance and schedule monitoring, and
- Statistics (passenger statistics, loading, and systemwide statistical information).

The transit agencies also were requested to provide information if they were planning, testing, implementing, or operating any on-board safety systems, such as:

- Silent alarms,
- Passenger clearance sensors, and/or
- Other safety systems.

II. Traveler Information

Traveler information systems provide travelers with information on one or more modes of transportation. These systems facilitate pre-trip, as well as en-route, decision-making. The four types of traveler information systems discussed in the questionnaire are:

- ☐ Trip planning information,
- ☐ Single and multi-mode trip planning information,
- ☐ In-terminal information systems, and
- ☐ In-vehicle information systems.

The section on trip planning information listed different locations where pre-trip information systems can be provided and asked transit agencies whether they offer such services as:

- Telephones,
- Internet access,
- Fax machines, and/or
- Kiosks.

The transit agencies were asked whether they currently implement, or plan to provide, single and multi-mode trip information, such as:

- Schedules and fares,
- System disruptions,
- Carpooling and parking,
- Incidents and weather,
- Routes and stop locations, and/or
- Ride-matching registration.

Transit agencies also were asked whether they have, or plan to offer, in-terminal information systems for passengers, such as:

- Electronic signs,
- Kiosks,
- Television monitors, and/or
- Annunciators.

Additionally, transit agencies were asked whether they plan to provide, or if they currently offer, in-vehicle information systems, such as:

- Electronic signs,
- Television monitors, and/or
- Annunciators.

III. Electronic Fare Payment

Electronic fare payment offers transit agencies the opportunity to integrate a new generation of electronic fare media and equipment. These systems provide more cost effective distribution of fare media and a more secure fare collection process. Transit agencies were asked whether they have or intend to provide any of the different technologies associated with electronic, or automated, fare payment, such as:

- Magnetic strip cards,
- Smart cards,
- Credit cards, and
- Proximity cards.

The transit agencies also were asked whether they have or intend to offer multi-carrier trip reservation and integrated billing systems. In addition, the agencies were given the opportunity to indicate the actual or potential set-up of their systems, such as:

- Between different modes,
- Utilization of ATM/credit cards, and/or
- Between different providers.

IV. Transportation Demand Management Technologies

Transportation Demand Management (TDM) technologies are those that combine innovative approaches and advanced technologies to better utilize existing infrastructure. Six TDM technologies discussed in the questionnaire are:

☐ Advanced communications,
☐ Automated service coordination,

- ☐ Transportation Management Center,
- ☐ Signal preemption,
- ☐ Dynamic ridesharing, and
- ☐ High occupancy vehicle lane access.

Advanced communication systems can include such technologies as:

- Analog land mobile,
- Digital,
- Trunked plus digital, and
- Other plus digital.

Automated service coordination involves multiple transportation providers in regions that provide service with the assistance of APTS technologies. This provides "one-stop shopping" for a traveler in a region. This is critical to integrating and coordinating the services available in a region. The questionnaire listed several system aspects that can be coordinated, including:

- Scheduling,
- Routing,
- Information systems, and
- Billing.

"Transportation Management Center" (TMC) refers to a facility that combines traffic and public transit operations, communications, and/or control. The agencies were asked whether there is a TMC in their region and whether the transit agency is a part of that TMC. They were also asked which technologies are used to integrate and distribute transit information from the TMC. The possible technologies that can be utilized include:

- Pagers,
- Telephones,
- Electronic signs on board,
- Information kiosks, and
- Cable television.

Signal preemption or traffic signal priority treatment for transit is a technology by which a traffic signal may be held green for longer than scheduled (or made green earlier than scheduled) so that a transit vehicle may pass through the intersection more quickly. Transit agencies were requested to provide information on whether they were planning, testing, implementing, or operating any intersection(s) with traffic signal priority treatment.

Dynamic ridesharing is used to obtain a ride for a single, one-way, or round trip; rather than for trips made on a regular basis. Transit agencies were requested to provide information about whether they were planning, testing, implementing, or operating any dynamic ridesharing programs.

The High Occupancy Vehicle (HOV) lane access technology involves a device/transponder on the vehicle that gives it access to HOV-only lanes. Transit agencies were requested to provide information on whether they were planning, testing, implementing, or operating any high occupancy vehicle lane access technology.

V. Paratransit Providers

Transit agencies were asked whether they currently have or intend to implement an automated paratransit system. Some of the possible automated paratransit system activities include computer-aided dispatch and automated scheduling.

Results of the Initial Inventory Survey

All eighteen of the technologies included on the survey questionnaire have at least two transit agencies either in the planning, implementation, testing, and/or operation stage. Eleven of the 18 technologies are still primarily in the planning stages for the majority of those agencies that are/will be utilizing them. Automated paratransit systems and advanced communications are the most popular technologies, with 14 transit agencies either in the planning, implementation, and/or fully operational stage foe each. Trip planning information and automated operations software are also quite popular; 12 agencies indicated some level of experience with each.

As for the level of technology deployment, more systems (nine) currently are operating advanced communications systems than any other technology mentioned. The technology with the next highest level of deployment is automated fare payment, with 6 transit agencies in the fully operational stage. Only automated service coordination and the Transportation Management Center concept did not have any agencies in the operational phase.

Interestingly, according to the survey results, most of the APTS technologies are either in the fully operational or planning stages, rather than the implementation or testing phases. Only three technologies (automated operations software, trip planning information, and automated paratransit systems) were found to have more than one transit agency in an implementation and/or testing phase. In addition, HOV vehicle lane access appears to be the least popular technology among the transit agencies that responded, with only two systems indicating any level of experience with it (one is in the planning stage and the other is operational). This is not surprising since exclusive, barrier-protected HOV lanes do not yet exist in Florida.

Table 1-2, on the following page, provides an APTS inventory summary for all of the transit agencies that participated in the survey. It details the technologies that each transit agency possesses, and what stage of development or deployment they are in currently.

Table 1-2
APTS Inventory Summary by Transit Agency

Transit Agency (# Vehicles in Operation)	Fleet Management					Traveler Information				Electronic Fare Payment		Transportation Demand Management Technologies						Paratransit Providers
	AVL	APC	Vehicle Component Monitoring	Automated Operations Software	On-Board Safety Systems	Trip Planning Information	Multi-Modal Trip Planning Information	In-Terminal Information Systems	In-Vehicle Information Systems	Automated Fare Payment	Multi-Carrier Reservation & Billing	Advanced Communi-cations	Automated Service Coordination	Transportation Management Center	Signal Preemption	Dynamic Ridesharing	HOV Lane Access	Automated Paratransit
Charlotte (20)												O						P
Collier (18)											P	O	P			P		O
Martin (28)	P		O	P/T			P				O	O	T					P/T
ECAT (41)				P		P		O		P								
HART (190)	P		P	P/O*	P	P/O*	P/O*	P	P	P/O*	O	P		P				O
JTA (174)	P	O	P	O	O	P	P	O	O	P/O		P	P	P	P	P		P
LAMTD (50)	P											P						P
MDTA (750)	O	P	P/IT	O	O	P/IT	O	P/O*	O	O		O	P		O		O	O
Palm Tran (140)				P	O	O	O		O	O		IT	P					IT
PCPT (43)				IT		P						O						IT
PSTA (144)										O		O						
Polk (27)			O	P	T	O	I				O	P	P			I		P
RTO/CAP (0)						P	P							P		O		
RTS (72)		P	P	I	P	P	P	P	P				P	P	P	P	P	P
SCAT (Sarasota) (28)	P			P	P	P	P			P		O	P	P				P
SCAT (Brevard) (138)	P		P	P	O	P	P	P				O	P					P
SunTran (5)			O				O											
TALTRAN (73)		P	P	P		IT		IT		O		O			P			O
Trans-Hernando (14)																		

Legend:
P - Planning
T - Testing
IT - Implementation/Testing
I - Implementation
O - Fully Operational

* Some activities are in the planning stages, while other activities are fully operational.

Tables1-3 through 1-20 present more detailed survey results (i.e., status and sophistication) for each of the APTS technologies included in the inventory questionnaire. It should be noted that when a system has indicated more than one status for any of its APTS activities, the highest status level achieved has been indicated in the tables. For example, HART indicated that some of its automated fare payment activities are in the planning stages, while other related activities are operational. In the table for this technology, then, HART is listed under the "operational" column only.

Table 1-3
APTS Inventory Summary: Automated Vehicle Location Systems

Technology	Status				Total Systems
	Operational	Implementation	Planning	Testing	
GPS	1	--	6	--	7
Signpost/Odometer	--	--	--	--	--
Dead-Reckoning	--	--	--	--	--
Loran-C	--	--	--	--	--
Others	--	--	--	--	--
Total Systems	1	--	6	--	**7**

NOTE: Table cell in lower right-hand corner indicates the total number of systems planning, testing, implementing, or utilizing an AVL technology.

Table 1-4
APTS Inventory Summary: Automatic Passenger Counters

Technology	Status				Total Systems
	Operational	Implementation	Planning	Testing	
Infra-Red Beams	1	--	1	--	2
Treadle Mats	--	--	1	--	1
Infra-Red Optic Sensors	--	--	--	--	--
Ultrasonic Frequency Sensors	--	--	--	--	--
Others	--	--	1	--	1
Total Systems	1	--	3	--	**4**

NOTE: Table cell in lower right-hand corner indicates the total number of systems planning, testing, implementing, or utilizing an APC technology.

Table 1-5
APTS Inventory Summary: Vehicle Component Monitoring Systems

Condition	Status				Total Systems
	Operational	Implementation	Planning	Testing	
High Engine Temp.	3	1[1]	3	--	7
Low Oil Pressure	3	1[1]	3	--	7
Brake/Alternator	1	--	--	--	1
Farebox	--	1[1]	--	--	1
RPM	1	--	--	--	1
Others	--	--	1	--	1
Did Not Specify	–	--	2	--	2
Total Systems	3	1	5	--	**9**

[1] MDTA indicated multiple statuses (i.e., planning and implementation/testing) for the various conditions that they are/will be monitoring.

NOTE: Table cell in lower right-hand corner indicates the total number of systems planning, testing, implementing, or utilizing vehicle component monitoring systems. In this case, the number does not equal the sum of the row totals since most systems are/will be measuring more than one vehicle condition.

Table 1-6
APTS Inventory Summary: Automated Operations Software

Activity	Status				Total Systems
	Operational	Implementation	Planning	Testing	
Computer-Aided Dispatch	2[1]	2	6	1[2]	11
Vehicle Performance	2	--	1	1[2]	4
Loading	1	1	1	1[2]	4
Driver Performance	1	--	2	1[2]	4
Schedule Monitoring	2	--	2	1[2]	5
Passenger Statistics	1	1	4	1[2]	7
Systemwide Statistics	1[1]	2	3	1[2]	7
Others	--	--	--	--	--
Total Systems	3	2	6	1	**12**

[1] HART indicated multiple statuses (i.e., planning and operational) for the various activities that they are/will be integrating.
[2] Martin County indicated multiple statuses (i.e., planning and testing) for the various activities that they are/will be integrating.

NOTE: Table cell in lower right-hand corner indicates the total number of systems planning, testing, implementing, or utilizing automated operations software. In this case, the number does not equal the sum of the row totals since many systems are/will be integrating more than one operations activity/function.

Table 1-7
APTS Inventory Summary: On-Board Safety Features

Feature	Status				Total Systems
	Operational	Implementation	Planning	Testing	
Silent Alarms	3	--	3	--	6
Passenger Clearance Sensors	--	--	2	1	3
On-Board Camera	1	--	--	--	1
Others	--	--	--	--	--
Total Systems	4	--	3	1	**8**

NOTE: Table cell in lower right-hand corner indicates the total number of systems planning, testing, implementing, or utilizing on-board safety features. In this case, the number does not equal the sum of the row totals since some of the systems are/will be integrating more than one system feature.

Table 1-8
APTS Inventory Summary: Trip Planning Information

Outlet	Status				Total Systems
	Operational	Implementation	Planning	Testing	
Touch-Tone Telephones	3[1]	--	2	--	5
Internet	1[1]	2[2]	5	--	8
Fax Machines	1	--	1	--	2
Kiosks	1[1]	2[2]	5	--	8
Others	--	--	1	--	1
Total Systems	3	2	7	--	**12**

[1] HART indicated multiple statuses (i.e., planning and operational) for the various outlets that they are/will be using to provide information.
[2] MDTA indicated multiple statuses (i.e., planning and implementation/testing) for the various outlets that they are/will be using to provide information.

NOTE: Table cell in lower right-hand corner indicates the total number of systems planning, testing, implementing, or utilizing trip planning information. In this case, the number does not equal the sum of the row totals since some of the systems are/will be providing more than one information outlet.

Table 1-9
APTS Inventory Summary: Trip Planning Information (Single Mode/Multi-Modal)

Information	Status				Total Systems
	Operational	Implementation	Planning	Testing	
Schedules, Fares	4[1]	--	5	--	9
System Disruption	2[1]	--	1	--	3
Carpooling & Parking	1	--	3	--	4
Incidents and/or Weather	--	--	--	--	--
Routes, Stop Locations	3[1]	1	5	--	9
Ride-Matching Registration	--	--	3	--	3
Others	--	--	1	--	1
Total Systems	4	1	6	--	**11**

[1]HART indicated multiple statuses (i.e., planning and operational) for the various types of information that they are/will be providing.

NOTE: Table cell in lower right-hand corner indicates the total number of systems planning, testing, implementing, or utilizing single mode and/or multi-modal trip planning information. In this case, the number does not equal the sum of the row totals since some of the systems are/will be providing more than one type of system information.

Table 1-10
APTS Inventory Summary: In-Terminal Information Systems

Technology	Status				Total Systems
	Operational	Implementation	Planning	Testing	
Electronic Signs	3[1]	1	2	--	6
Kiosks	2[1]	1	2	--	5
Television Monitors	--	1	3	--	4
Annunciators	2[1]	--	2	--	4
Others	--	--	--	--	--
Total Systems	3	1	3	--	**7**

[1]MDTA indicated multiple statuses (i.e., planning and operational) for the various technologies that they are/will be utilizing.

NOTE: Table cell in lower right-hand corner indicates the total number of systems planning, testing, implementing, or utilizing in-terminal information systems. In this case, the number does not equal the sum of the row totals since some of the systems are/will be utilizing more than one technology.

Table 1-11
APTS Inventory Summary: In-Vehicle Information Systems

Technology	Status				Total Systems
	Operational	Implementation	Planning	Testing	
Electronic Signs	2	--	2	--	4
Television Monitors	1	--	2	--	3
Annunciators	3	--	2	--	5
Others	--	--	--	--	--
Total Systems	3	--	2	--	**5**

NOTE Table cell in lower right-hand corner indicates the total number of systems planning, testing, implementing, or utilizing in-vehicle information systems. In this case, the number does not equal the sum of the row totals since some of the systems are/will be utilizing more than one type of technology.

Table 1-12
APTS Inventory Summary: Automated Fare Payment

Technology	Status				Total Systems
	Operational	Implementation	Planning	Testing	
Magnetic Strip Cards	6[1,2,3]	--	1	--	7
Smart Cards	--	--	2[2]	--	2
Credit Cards	--	--	--	--	--
Proximity Cards	--	--	--	--	--
Others	--	--	1[1]	--	1
Total Systems	6	--	2	--	**8**

[1] HART indicated multiple statuses (i.e., planning and operational) for the various technologies that they are/will be utilizing.
[2] JTA indicated multiple statuses (i.e., planning and operational) for the various technologies that they are/will be utilizing.
[3] MDTA indicated that the magnetic strip cards are only being utilized on its rail mode.

NOTE: Table cell in lower right-hand corner indicates the total number of systems planning, testing, implementing, or utilizing automated fare payment systems. In this case, the number does not equal the sum of the row totals since some of the systems are/will be utilizing more than one type of technology.

Table 1-13
APTS Inventory Summary: Multi-Carrier Reservation and Billing Systems

Set-Up	Status				Total Systems
	Operational	Implementation	Planning	Testing	
Between Different Modes	2	--	1	--	3
With ATM and/or Credit Cards	--	--	--	--	--
Between Different Providers	2	--	1	--	3
Others	--	--	--	--	--
Total Systems	3	--	1	--	**4**

NOTE: Table cell in lower right-hand corner indicates the total number of systems planning, testing, implementing, or utilizing multi-carrier reservation and billing systems. In this case, the number does not equal the sum of the row totals since some of the systems are/will be utilizing more than one type of set-up.

Table 1-14
APTS Inventory Summary: Advanced Communications

Technology	Status				Total Systems
	Operational	Implementation	Planning	Testing	
Analog Land Mobile	3			--	3
Digital	1	--	2	--	3
Trunked + Digital	3	--	1	--	4
Other + Digital	--	--	--	--	--
Others	2	1	1	--	4
Total Systems	9	1	4	--	**14**

NOTE: Table cell in lower right-hand corner indicates the total number of systems planning, testing, implementing, or utilizing advanced communications systems.

Table 1-15
APTS Inventory Summary: Automated Service Coordination

System Aspect	Status				Total Systems
	Operational	Implementation	Planning	Testing	
Scheduling	--	--	7	1	8
Routing	--	--	7	1	8
Information Systems	--	--	6	--	6
Billing	--	--	2	--	2
Others	--	--	1	--	1
Total Systems	--	--	8	1	**9**

NOTE: Table cell in lower right-hand corner indicates the total number of systems planning, testing, implementing, or utilizing automated service coordination. In this case, the number does not equal the sum of the row totals since some of the systems are/will be automating the coordination of more than one system aspect.

Table 1-16
APTS Inventory Summary: Transportation Management Center

Outlet	Status				Total Systems
	Operational	Implementation	Planning	Testing	
Pagers, Telephone	--	--	1	--	1
Electronic Signs On Board	--	--	3	--	3
Information Kiosks	--	--	3	--	3
Cable Television	--	--	3	--	3
Others	--	--	1[1]	--	1
Total Systems	--	--	5	--	**5**

[1] Although a TMC does not currently exist in its region, SCAT (Sarasota) indicated that it is involved in the planning of one and is, therefore, represented in this table under the "others" category (since no specific information outlets were indicated).

NOTE: Table cell in lower right-hand corner indicates the total number of systems planning, testing, implementing, or utilizing one or more outlets to integrate/distribute transit information as part of an existing TMC.

Table 1-17
APTS Inventory Summary: Signal Preemption

Status				Total Systems
Operational	Implementation	Planning	Testing	
1	--	3	--	**4**

Table 1-18
APTS Inventory Summary: Dynamic Ridesharing

Status				Total Systems
Operational	Implementation	Planning	Testing	
1	1	3	--	**5**

Table 1-19
APTS Inventory Summary: High Occupancy Vehicle Lane Access

Status				Total Systems
Operational	Implementation	Planning	Testing	
1	--	1	--	**2**

Table 1-20
APTS Inventory Summary: Automated Paratransit

Activity	Status				Total Systems
	Operational	Implementation	Planning	Testing	
Computer-Aided Dispatch	2	1	6	1[1]	10
Scheduling	4	2	7	1[1]	14
Comments/Complaints	--	--	1	--	1
Others	--	--	--	--	--
Total Systems	4	2	7	1	**14**

[1]Martin County indicated multiple statuses (i.e., planning and testing) for the various activities that they are/will be integrating.

NOTE: Table cell in lower right-hand corner indicates the total number of systems planning, testing, implementing, or utilizing automated paratransit systems. In this case, the number does not equal the sum of the row totals since some of the systems are/will be automating more than one paratransit activity.

FOLLOW-UP APTS INVENTORY SURVEY

A follow-up survey to the APTS inventory survey was administered to the transit agencies. Initially, only those transit agencies that responded to the first survey were called and the follow-up questionnaire was administered as a telephone interview with the staff members who filled out the original inventory questionnaires. Eventually, all thirty of the transit agencies received a copy of the follow-up survey by e-mail to review and complete. The follow-up questionnaire sought the opinions of transit agency staff on such topics as procurement methods of APTS products and services, level of conformity with national ITS architecture, available funding sources, extent of public awareness, and sophistication of benefits analysis, among others. Ten of the 30 transit agencies responded to the follow-up survey; these 10 agencies all responded to the original APTS inventory survey, as well. This results in an overall agency response rate of 33 percent, and a response rate of about 53 percent when taking into account only the 19 original survey respondents.

Follow-Up Survey Questionnaire

The follow-up survey questionnaire consisted of nine major topic areas related to APTS and its deployment. The topic areas that were included are:

- ☐ General
- ☐ Funding
- ☐ Integration
- ☐ Equipment compatibility
- ☐ Staff opinions
- ☐ Public awareness/involvement
- ☐ Partnering
- ☐ Rural areas
- ☐ Visions of the future

Following are brief descriptions of each of the topic areas. A copy of the follow-up APTS inventory questionnaire is included in Appendix B.

General

This first section of the survey sought information on the level of consideration given to APTS in the planning and operations of the transit agency, as well as on the importance of and efficiencies expected from APTS. Another topic covered in this section was the expected roles that the FDOT Central Office, FDOT District Offices, MPOs, and local government should play in the development and deployment of APTS. In addition, the transit agencies were asked which factors impede the development and deployment of APTS and how APTS can be made more effective in Florida.

Funding

This section sought the opinions of the transit agencies on funding issues related to APTS. For example, questions were asked on the importance of seeking funding and having funding provided for APTS projects. Also, agencies were asked to share any of the specific funding sources that have been used for their APTS projects.

Integration

This 12-question portion of the survey dealt primarily with ITS architecture (at various levels–national, regional, etc.) and the integration of APTS into it. Selected questions addressed conformity with the national ITS architecture, the implications for APTS as a result of a statewide ITS strategic plan, and the preferred level for ITS architecture. One of the issues raised in this section is the level of importance that should be given to merging APTS into regional ITS activities (e.g., TMCs). Agencies also were given the opportunity to identify their preferred levels of integration (i.e., route, city, region, state) for each of the APTS technologies that were included in the original inventory questionnaire.

Equipment Compatibility

This section asked the transit agencies to provide their opinions on what level of uniformity should exist for each of the technologies included in the inventory survey. For example, in the case of APCs, there are a variety of technologies that can be utilized to collect the desired passenger/vehicle data. The actual mechanism used to count ons/offs can be a treadle mat, infra-red beam, or optical sensor. Locational reference of the vehicle along the route can be detected by hubometers, radio signposts, or GPS. There are even options for retrieval of the stored information from the APC's central processing unit. As a result, with so many possible variations to choose from when developing an APC system or some other APTS application, it is important to know what level of uniformity (i.e., across route, city, region, state) agencies would like to see associated with the options.

Staff Opinions

Similar to the previous sections, this part of the survey allowed agency staff to provide their opinions on a variety of topics related to the various APTS technologies. Topics addressed in this section included: procurement methods, types of technology, manufacturers, performance ratings, recommendations for change/improvement to a technology, measurable benefits, problems, benefits analysis, and impacts to agency staff and maintenance personnel.

Public Awareness/Involvement

This section queried the transit agencies about their satisfaction with the levels of awareness of APTS on the part of the public and public officials. The agencies were also asked to provide suggestions on the appropriate methods that could be utilized to increase the awareness and involvement of the public and public officials.

Partnering

This part of the survey sought information on whether transit agencies currently are participating in public-public and/or public-private partnering. Also, transit agency staff were asked to discuss any opportunities that they believe exist for public-public and/or public-private partnerships for APTS.

Rural Areas

This brief section included only one question that asked transit agency staff to provide their opinions on the benefits that might result from the application of APTS in rural areas.

Visions of the Future

The final portion of the follow-up survey involved discussion of any successes that transit agencies have had thus far with APTS deployment. Agency staff also were asked to discuss the factors that fueled their success and any activities that were undertaken to ensure/maintain the success. Questions were also included that asked about the potential impact of the ITS strategic plan on the coordination of ITS-transit projects, and the long-term vision of APTS. Finally, transit agency staff were asked to provide their opinions on the Bus Rapid Transit mode and the application of the Intelligent Vehicle Initiative to transit.

Results of the Follow-Up Survey

Following are summaries of the results for selected questions within each of the questionnaire's topic areas, as compiled from the information provided by the 10 responding transit agencies.

General

The follow-up survey revealed that only three of the transit agencies addressed APTS in their transit development plans, and a fourth incorporated it "to some degree." Another agency indicated that it plans to address the ITS-transit issue in a future meeting. Three agencies did not address the issue at all in their TDPs; however, one of these indicated that the topic had been discussed during the TDP process. One agency indicated that it was not sure whether this issue had been addressed in its TDP. It should be noted that the question did not apply to one particular agency, RTO-CAP, since it does not produce a TDP.

Seven agencies have given consideration to ITS-transit in their overall operational scheme. Five of these agencies indicated their respective levels of consideration to be "some" or "not much." Another of these agencies indicated that it has given "quite a bit [of consideration] right now." The last of these agencies responded that "1-5% of [its] overall operational scheme" currently considers ITS.

Table 1-21 presents the responses for the question in the General section that relates to the importance of including ITS-transit in the transit planning process.

Table 1-21
General Section: Question #3

Question	Response
How important is it to include APTS in the planning process for transit?	Very Important – 7 Somewhat Important – 1 Not Important – 1 No Opinion - 1

According to the responding agencies, the expected levels of efficiency resulting from APTS activities range from "marginal" to "moderate" to "very good." One respondent expects ITS-transit to produce "at least [a] 10 to 30 percent improvement in efficiency." Furthermore, one responding agency indicated that it expects its APTS activities to help increase system ridership, improve its billing and other financial functions, and improve trip verification.

Table 1-22 shows the responses for the fifth question in this section, which relates to the transit agencies' primary motivation(s) for implementing their ITS-transit activities.

Table 1-22
General Section: Question #5

Question	Response
What is the primary motivation for APTS?	Service Effectiveness – 7 Safety – 2 Efficiency – 1

When asked how ITS-transit can be made more effective in Florida, six of the responding transit agencies indicated that funding is essential for any progress to be made. Additionally, seven agencies say that the cost of APTS and/or the lack of funding is the key factor currently impeding the deployment of ITS-transit.

The agencies submitted a range of opinions regarding the roles of the "various players" (i.e., FDOT Central Office, FDOT Districts, MPOs, and local government) in the development and deployment of ITS-transit. Seven of the responding agencies listed an assortment of roles for the "players." For the most part, education and funding were seen as being two of the more important roles. Other roles that were suggested included general support and data collection/reporting. Two of the respondents, however, indicated that the "various players" have "no role" in ITS-transit, with one of these agencies suggesting that it is "strictly up to the local [transit] agencies in Florida."

Funding

The responses for the opening question of this section are provided in Table 1-23. This particular question asked the transit agencies for their respective opinions on how important it is to *provide funds* for ITS-transit activities in public transportation projects. Interestingly, the distribution of responses is identical for the question on how important it is to *seek funding* for these same activities.

Table 1-23
Funding Section: Question #1

Question	Response
How important is it to provide funds for APTS in Public Transportation projects?	Very Important – 8 Somewhat Important – 2 No Opinion - 0

This section also asked the agencies what percent of the budget should be allocated for ITS-transit activities. Four of the respondents either did not know or had no opinion, and one found the question "impossible to answer." Four of the agencies, however, did provide their suggested distributions. One agency indicated a transit budget allocation of 10 percent to APTS. The other three proposed allocations for both the transit agency and state budgets: 10-15 percent of each budget; 2 percent of each budget; and 5 percent and 1 percent of the state and transit agency budgets, respectively.

Integration

The responses for three of the questions in this section of the survey are shown in Table 1-24. The questions deal with the topics of conformity and ITS architecture–specifically, conformity of the regional ITS architecture with that of the national ITS architecture and conformity of individual ITS-transit projects with the regional architecture.

Table 1-24
Integration Section: Questions #1, 5, & 7

Question	Response
How important is it for the regional ITS architecture to conform to the national ITS architecture?	Very Important – 8 Somewhat Important – 0 Not Important – 0 No Opinion - 2
How important is it for individual ITS-transit projects to fit into the overall architecture?	Very Important – 7 Somewhat Important – 2 Not Important – 0 No Opinion - 1
Do you think it is important to merge APTS into the regional ITS architecture?	Very Important – 8 Somewhat Important – 1 Not Important – 0 No Opinion - 1

The agencies were also asked whether a Florida-specific ITS architecture should be statewide, regional, or local in scope. Seven of the respondents believe the architecture should be statewide, with one of these indicating that "nationwide" may even be preferable. Only one agency indicated that the architecture should be regional. The other two agencies offered no opinion on this topic.

In Table 1-25, the agencies' responses for another of the questions in this section are presented. This particular question (#9) queried the agencies about their opinions on merging transit with regional transportation services and traffic operations to create regional Transportation Management Centers.

Table 1-25
Integration Section: Question #9

Question	Response
Do you think transit should be combined with regional transportation services and traffic operations in a regional Transportation Management Center?	Yes – 8 No – 1 No Opinion - 1

The agencies were asked next to review a variety of technologies and decide at what level (route, city, region, or state) integration should occur for each. Nine of the agencies provided responses for this particular section and, for the most part, a consensus opinion was present for many of the technologies. For example, the majority of the agencies believe vehicle component monitoring systems should be integrated at the city level (i.e., systemwide). Many of the agencies also think automated fare payment systems, automatic passenger counters, on-board safety systems, and automated services should be integrated at the city level, as well.

The majority of respondents indicated automatic vehicle location systems should be integrated at the regional level. Many of the agencies also indicated that automated operations software, advanced communication systems, automated paratransit systems, and dynamic ridesharing should be regional in nature. On the issue of multi-carrier reservation and billing, there was an equal number of votes for integrating at the city and regional levels. The issue of traffic signal priority was also split between city and region.

Interestingly, for traveler information systems, a number of agencies indicated both "region" and "state" in their responses. When combined with those systems who voted solely for state or region, a total of seven systems indicated these higher levels of integration. This seems to indicate a particular desire to have a traveler information system implemented on a large scale.

Equipment Compatibility

The sole question in this section asked the agencies to decide at what level (route, city, region, or state) equipment compatibility/uniformity should occur for each APTS technology. Nine of the agencies provided responses and a consensus opinion was present for a number of the technologies. For example, uniformity of vehicle component monitoring systems at the city level was indicated by the highest number of transit agencies. Most of the agencies also think multi-carrier reservation and billing and traffic signal priority should be uniform at the city level, as well.

The agencies indicated a preference for regional uniformity for the following technologies: automatic vehicle location systems, automated operations software, traveler information systems, automated services, advanced communication systems, and automated paratransit systems. For automatic passenger counters, there was an equal number of votes for equipment compatibility at the city and regional levels. This was also the case for automated fare payment systems. In addition, dynamic ridesharing was split evenly between the regional and state levels.

It should be noted that one agency indicated both "region" and "state" in its response for the suggested uniformity of on-board safety systems. When combined with those systems who voted solely for state or region, a total of four systems indicated these higher levels of integration. While this may seem to indicate a desire to have on-board safety systems implemented on a larger scale, three other systems preferred the city level for this technology.

Staff Opinions

As discussed previously, this section of the questionnaire dealt with staff opinions on a variety of topics relating to the development and deployment of ITS-transit technologies. The agencies were queried on procurement methods, type(s) of technologies, performance ratings, measurable benefits, and related impacts, among other topics. Unfortunately, many of the agencies declared a lack of sufficient practical experience with the different technologies to form an opinion about many of the topics. Therefore, many of the questions in this section were left mostly blank.

The first question in this section asked for staff opinions on the procurement methods, type(s), and manufacturers of the various ITS-transit technologies. Responses were provided for only half of the 14 technologies, and advanced communication systems was the only technology with widespread use: five agencies have operational systems, with four of these utilizing 800-megahertz radio systems.

The agencies were then asked to provide performance ratings for the various technologies that they are using, as well as any recommendations for improvement(s) that they might have. The agencies provided limited information for only six of the technologies. However, the vast majority of the ratings are quite good. One agency scored the performance of its vehicle component monitoring system at 100 percent. The only complaint the agency had was that they would like to see more components be monitored (specifically mentioned were brake and seatbelt monitoring). Two different agencies rated their on-board safety systems. One rated its system as "excellent" and believed no improvements were necessary; the other rated its system at 80 percent and cited a video surveillance system that has 8-hour tapes on a 10-hour route as something in need of change. Interestingly, this second agency also indicated that a switch to a digital format would also improve its system since this would make piles of tapes laying around obsolete.

Traveler information systems was the only technology that received a "poor" rating. The agency that provided this information for its electronic signs indicated that the recommended solution was to "buy a different system." This seems to indicate a problem with the vendor/manufacturer rather than with the technology, itself. Conversely, the other transit agency that commented on this particular technology indicated that its traveler information system was "excellent" and in need of no improvements or changes. Automated fare payment systems also received an "excellent" rating from one of the agencies. Additionally, several of the agencies gave very high approval ratings to their advanced communication systems, and did not suggest any recommendations for change.

As for multi-carrier reservation and billing, one system gave the reservation portion of the technology a 95 percent rating and indicated that the billing portion was operating at 85 percent accuracy. This agency indicated a desire to improve the reservations function via automated customer dial-in (by which a person could call in and make his or her own reservations using automated touch-tone menus). It also suggested that it would like to see the accuracy of its billing function improve to 98 percent.

Public Awareness/Involvement

This portion of the survey concentrated on the agencies' satisfaction with the level of public awareness for ITS-transit. Seven of the agencies indicated that they are not satisfied with the current level of public awareness. Two other agencies did not have an opinion, and one indicated that it is happy with the public's awareness of APTS.

The agencies were also asked whether they believed that public officials were aware of ITS-transit. Three of the agencies indicated that they do not believe that public officials are aware of it, while two agencies think officials are indeed aware of ITS-transit. Another agency suggested that, while public officials may be aware of ITS-transit, their awareness is "very low." Additionally, three agencies either did not have an opinion or did not know about the level of public official awareness.

Finally, the agencies were asked for their opinions on the appropriate methods to increase the level of awareness for APTS. Most of the respondents indicated that a process of education is needed. The various methods of educating the public and officials that were recommended included: presentations, television and radio coverage, newspaper articles, demonstration projects, and information distributed via the Internet (e.g., a Frequently Asked Questions [FAQ] page about APTS on a transit website).

Interestingly, one of the agencies suggested standardization of the APTS technologies as a possible method for increasing awareness. This agency further indicated that funding would lead to standardization.

Partnering

On the issue of partnering, two agencies have set up partnerships with their respective counties to utilize county radio systems. A third system has a similar agreement with its city to utilize the existing radio system. This particular system has also partnered with its city for traffic engineering services. Another agency indicated having a public-public partnership (with another public transit agency) for its scheduling functions. Yet another agency is planning to partner with the public transit provider in a neighboring county to provide cross-county service; however, it was indicated that this will occur "several years down the line." Finally, only one system indicated having a public-private partnership (with Greyhound bus service to distribute its passes), though not for any APTS-related activities.

The agencies were also asked to provide their ideas for any opportunities that may exist for public-public and/or public-private partnerships involving APTS. Not many of the respondents had any ideas; however, one system did mention AVL as a possibility and another suggested traveler information and advanced communications systems as potentials for partnerships.

Rural Transit

The responding transit agencies provided a number of benefits that they believe will result from the application of APTS in rural areas. Many of the agencies think vehicle location, scheduling of trips, and communication will be the most significant benefits. Traveler information and the dispatching function were also seen as benefitting from the implementation of APTS. One system even pointed to the increase in overall efficiencies that would be expected to occur as an important benefit.

Visions of the Future

Many of the agencies believe that the impact of ITS-transit in their respective areas has been relatively low to moderate thus far. However, they also believe that increased success can be attained in the future through a number of important activities. Those that were mentioned include securing funding (as well as seeking to reduce the costs associated with APTS), planning, education, marketing, increasing public awareness, setting performance measures for the technologies, and establishing partnerships. Communication was one of the primary activities mentioned by a number of agencies.

One agency indicated that it would be valuable for agencies to “compare notes when [they] are done,” and another stressed the importance of “celebrating [their] successes.”

As far as the outlook for the future, many of the responding agencies seem to subscribe to the belief that ITS-transit is “very important and will happen.” In fact, one agency suggested that, with APTS, “multi-modal trips should be possible from Tallahassee to Key West.” It was also indicated that integration at various levels (i.e., regional, state, national) will be a necessary ingredient. Several agencies discussed the specific technologies that they envision utilizing in the future, including AVL, automated scheduling, and customer information systems (e.g., real-time bus arrival and departure information). Some of the expected benefits of future APTS deployment were also mentioned, such as more effective and efficient service and reduced paperwork.

Two initiatives relating to future development of ITS-transit are Bus Rapid Transit (BRT), an upgraded bus service that takes advantage of a number of APTS technologies to improve service efficiencies and speeds, and the Intelligent Vehicle Initiative (IVI), which attempts to utilize technology to help buses operate more safely and effectively . All ten of the responding agencies believe that BRT should be integrated into our surface transportation system. Additionally, eight of the respondents indicated that IVI should be incorporated into transit, as well.

STAKEHOLDER INTERVIEWS

With the assistance of the FDOT PTO, a number of “APTS stakeholders” from around the state were identified to take part in a series of stakeholder interviews and meetings. It was determined that these stakeholders, at a minimum, should consist of FDOT senior management staff such as the District Directors of Operation, District Directors of Planning, and Public Transportation Managers. Even though these "stakeholders" are not directly dealing with transit, they were selected because they are responsible for policy and funding allocations in each FDOT district. It is also the case that they can provide the perspective of traditional transportation professionals on the topic of ITS-transit. A total of 35 stakeholders were interviewed over the course of 6 separate meetings.

A modified version of the follow-up APTS inventory survey questionnaire was administered to the stakeholders. It should be noted that the FDOT District 1 stakeholders group included several County Commissioners. Additionally, the Miami-Dade MPO was also represented in the FDOT District 6 stakeholders group.

Stakeholder Interview Questionnaire

The stakeholder interview questionnaire consisted of eight major topic areas related to ITS-transit. The topic areas that were included are:

- ☐ Introduction
- ☐ Development and deployment
- ☐ Funding
- ☐ Integration
- ☐ Public awareness and involvement
- ☐ Partnering
- ☐ Rural areas
- ☐ Visions of the future

Following are brief descriptions of the topic areas. A copy of the stakeholder interview questionnaire is included in Appendix C.

Introduction

This opening section of the questionnaire attempted to determine the stakeholders' level of familiarity with the topic areas of ITS and APTS. For those stakeholders that were not very familiar with these topics, a brief synopsis of APTS was provided that outlined its basic aspects.

Development and Deployment

The Development and Deployment section asked the stakeholders for their views on ITS, as well as for their opinions on APTS and its importance compared to other ITS applications. They were also asked about the importance of including APTS in the project development process and whether they believe that APTS will improve the performance of public transportation. Some of the other topics covered in this section were the expected roles that the FDOT Central Office, FDOT District Offices, MPOs, and local government should play in the development and deployment of APTS; the potential factors that may impede the development and deployment of APTS; and how APTS can be made to be more effective in Florida.

Funding

The Funding section asked the stakeholders whether the State and local governments should be investing more in APTS. They were also queried on several other topics, such as how important they believe it is to seek funding for APTS, how TEA-21 views funding sources for APTS, and what portion (if any) of the work program budget should be allocated for APTS-related activities.

Remaining Topic Areas

The Integration, Public Awareness and Involvement, Partnering, Rural Areas, and Visions of the Future sections were, for the most part, identical to the corresponding sections in the follow-up APTS inventory survey questionnaire.

Results of the Stakeholder Interviews

Following are summaries of the discussions that occurred at the various stakeholder meetings and interviews that were held for purposes of this effort. It should be noted that Appendix D contains a listing of all the individuals who participated in each of the stakeholder meetings/interviews.

Summary of FDOT District 1 Stakeholder Interviews

The first stakeholder meeting was held with the FDOT District 1 stakeholders at the County Administration building in Arcadia on Friday, May 12, 2000. The stakeholders for District 1 were identified with the help of the FDOT project manager and the district public transportation manager. A total of 10 stakeholders participated in this meeting.

The District 1 stakeholders stated that APTS is of equal importance to other ITS applications. A lack of funding was cited as the factor that impedes the development and deployment of ITS-transit. They believe that it is "imperative" to seek funding for ITS-transit. As a result, when asked about the role of "various players" (FDOT central office, FDOT district office, MPOs, and local governments), they indicated that the role of those groups should be to provide funding.

Most of the stakeholders were not aware of ITS architecture or the ITS Strategic Plan. After a brief explanation of ITS architecture, everyone thought it was important for the regional ITS architecture to conform to the national ITS architecture. Some stakeholders thought it was important to merge transit into TMCs. Others thought it might not be very cost effective.

The stakeholders were satisfied with the level of public awareness of ITS-transit. One method suggested to increase public awareness of ITS-transit was to put a survey on the Internet with a reward for participation. One stakeholder suggested the way to generate ridership is to "go to the source of where it is and how it is. Listen and understand it. Go on buses. Create a desire to be a part of the big solution."

Some of the suggestions that were provided for public-public and public-private partnerships included the following:

- sponsorship with fare cards
- advertising on kiosks
- corporate credit cards
- involvement of schools and hospitals

Some of the activities that were mentioned to assure and maintain ITS-transit success included:

- increase convenience and comfort
- increase amount of riders
- increase simplicity to use
- share experience and success stories

Everyone involved in the discussion thought Bus Rapid Transit should be included in the surface transportation system. When asked about the importance of incorporating the Intelligent Vehicle Initiative in transit, one transit representative replied, "If other areas are seeing a significant reduction in accidents, then the answer is 'yes.' If not, then the answer is 'no.' Put the money in other technologies."

Summary of FDOT District 2 Stakeholder Interviews

The FDOT District 2 stakeholder meeting was held at the FDOT Urban Office in Jacksonville on Wednesday, May 24, 2000. The stakeholders for District 2 were identified with the help of the FDOT project manager. This stakeholder group consisted of only FDOT District 2 staff, with a total of three participants.

All of the participating stakeholders thought ITS-transit has the potential to attract the "choice rider." Some of the issues mentioned that participants believe keep transit from attracting discretionary riders are land use, densities, and cheap parking. As one stakeholder stated, “Not many people crave access to transit.” To illustrate this point, the example of downtown Jacksonville was given, where it is much cheaper to drive one’s car than to ride transit because parking costs $0.25 for two hours. One stakeholder said that the general public is “not convinced about transit, let alone ITS-transit.”

When asked about the role of the “various players” in the development and deployment of ITS-transit, the stakeholders indicated that FDOT does not promote anything, but will support it once initiated, i.e., FDOT is only a supporting agency. One person said, “Transit agencies should decide what they want to do and come to FDOT for funding.” Additionally, the stakeholders mentioned that FDOT should be an advocate. They also believe that FDOT would be in a better position to fund ITS-transit if a safety element, such as panic buttons, was present.

Regarding funding, the stakeholders thought that no existing funding sources should be used for ITS-transit. One person also mentioned that “only existing funding sources should be used for commuter assistance programs.“

The stakeholders were not very familiar with either the ITS Strategic Plan or ITS architecture. However, they did believe that it was necessary for individual ITS-transit projects to fit into the overall architecture. All of the stakeholders thought it was important to integrate ITS-transit into regular ITS, as well. Even though they thought transit should be included in the new TMC in Jacksonville, it was indicated that there has been no discussion to include transit in that building. The stakeholders also mentioned that there was an ITS architecture workshop at the Jacksonville Transportation Authority (JTA) office at the beginning of this year. Although there were no representatives from JTA in attendance, everyone else was represented (such as emergency operations, fleet operations) and there was a lot of information sharing and opinion exchange.

The stakeholders stated that they were not satisfied with the level of public awareness of ITS-transit. Having more information at Florida Transit Association conferences was one appropriate method suggested to increase awareness. In fact, one of the stakeholders thought that ITS-transit “should be at the top of the list” at Florida Transit Association conferences.

The stakeholders also indicated being disappointed with the level of ITS-transit success in their area. One of the suggestions given to grow ITS-transit was to have “better coordination” with the “DOT, MPO, and transit agencies all having a role.”

Summary of FDOT District 4 Stakeholder Interviews

The FDOT District 4 stakeholder meeting was held via conference telephone call on Thursday, July 27, 2000. A total of four stakeholders participated in the discussion.

The stakeholders all saw a need for ITS-transit. One stakeholder believes that "as the room for roads decreases, APTS becomes more necessary." As a result of this need, the District is establishing a master plan for ITS-transit. One stakeholder stated, "We are funding an AVL system, and dispatching and re-routing projects." The creation of this plan was encouraged by the idea that one stakeholder expressed: "the longer you wait to initiate and create this, the harder it will get, and the more expensive it will get."

Integration, education, and increased communication were often stated as primary necessities for the success of ITS-transit. One stakeholder said that the traditional paradigm of "just build more roads" hurts ITS-transit. Another suggestion was to "provide a forum for the agencies to gather each month to help integrate each fragmented project into a single division."

On the issue of the "various players" involved with ITS-transit, all of the stakeholders agreed that ideally:

- the central office deals with policy programs;
- the districts provide expertise and guidance;
- the MPO provides coordination, endorsement, and fund approval; and
- the local level does the implementation.

One stakeholder indicated that seeking funding for ITS-transit was very important, although another added it was important not to just "throw money at it. It needs to be planned and managed. Need the most bang for the buck. Prioritize deployment." All of the stakeholders stated that funding should be project related, not allocated specifically to ITS-transit.

All of the stakeholders believe that it is very important for ITS architecture to conform to the national ITS architecture. They stated a desire for "all systems to be interchangeable." They also thought that it is important to combine regional transportation services and traffic operations in a regional Transportation Management Center. As a result, they are "building a traffic management center to house various providers (e.g., FHP, FDOT, traffic operations, transit, APTS)."

The stakeholders indicated not being satisfied with the public awareness level of ITS-transit. Additionally, one stakeholder said, "The officials are also not aware." In order to increase public awareness, they believe "real time information is the most useful tool and form of self-marketing."

One stakeholder said that some of the opportunities that exist for public-public and public-private partnerships for ITS-transit are "smart bus stops with real time information. Ads can be placed there." That particular stakeholder also suggested "smart cards with outside vendors" and "entering into joint development with park and ride."

On the issue of ITS-transit in rural areas, one stakeholder indicated that "scheduling and dispatch and service" were the main benefits.

To assure and maintain the success of ITS-transit, one stakeholder suggested a need to "sit down and form a master plan," then "prioritize deployment." This stakeholder further stated that "real time information is the best option to get choice riders. Smooth, clean, comfortable is needed to get commuters."

One stakeholder believes that Bus Rapid Transit should be integrated into the surface transportation system. However, it was stated that "there is a unspoken policy to try bus, then rail. We are interested in BRT." The stakeholders also agreed that it was important to incorporate the Intelligent Vehicle Initiative in transit, as well.

Summary of FDOT District 6 Stakeholder Interviews

The District 6 stakeholder meeting was held at the FDOT office in Miami on Wednesday, June 21, 2000. The stakeholders for District 6 were identified with the help of the FDOT project manager and the district public transportation manager. This stakeholder group consisted of FDOT District 6 staff, a Miami-Dade Transit Authority (MDTA) representative, and an MPO representative. A total of seven stakeholders participated in the meeting. The meeting kicked off with a 10-minute presentation on the project by CUTR staff.

When asked whether the roles of all the participating agencies were defined regarding ITS-transit development and deployment, the MDTA representative replied that everyone was cooperative. One of the stakeholders mentioned that a lot of progress has been made since 1997, but some things are still not clear. Another stakeholder mentioned that small cities are trying to do their own circulation. It was stated that these small cities should establish inter-local agreements with the transit agency.

All of the stakeholders believe that ITS-transit has the potential to improve transit operations. However, it was mentioned that one obstacle to the deployment of ITS-transit is that transit operators are often not aware of how to operate the technology. Additionally, it was indicated that the County government takes a very long time to procure anything. One stakeholder said, "Dealing with bureaucracy is a major problem."

None of the stakeholders are satisfied with the level of funding for ITS-transit. One stakeholder said that they "don't have money for anything. Someone has to have the vision of what the whole partnership should look like. We have been pushing such a partnership." It was mentioned that, since the County rolled back the gas tax, there is not enough money. One of the stakeholders said, "FTA [Federal Transit Administration] and other federal agencies are expecting major portions to come from local government. It is a problem here because the $0.02 gas tax was cut."

Most of the stakeholders indicated being aware of the ITS Strategic Plan and ITS architecture. There were differing opinions on the level of conformity, but the consensus was that ITS-transit architecture should be in conformity with at least the local architecture.

The participants thought that rail riders are more aware of ITS-transit than other transit riders. They believe that most of the general public is only aware of what the Miami Herald reports and, because that particular newspaper only prints stories about cars, the public is not informed. It was suggested that ITS-transit should come across as "moving people, rather than cars." One of the stakeholders indicated that there was no early awareness of the technology. Variable message signs were suggested as a method to increase public awareness of ITS-transit.

The stakeholders provided many visions of the future for ITS-transit. One person said that the "best contribution is to provide reliable, accurate information about transit." Other suggestions included specialized Bus Rapid Transit on different corridors and producing good Metrorail projects. The need for an integrated transportation system was also made clear. Some stakeholders think that ITS will be there and working 10 years from now. One person said, "Even if there is only one bus, then that bus will have all APTS."

Summary of FDOT District 7 Stakeholder Interviews

The FDOT District 7 stakeholder meeting was held at the District 7 office in Tampa on Friday, July 28, 2000. This stakeholder group consisted of FDOT senior management staff and members of the ITS working group. A total of five stakeholders participated in this meeting.

Everyone in attendance saw the potential for ITS-transit. One stakeholder indicated a belief that ITS-transit should be included in the transit development plan (TDP) of a transit agency. When asked about the role that the "various players" should play in the development and deployment of ITS-transit, one stakeholder said that the "role of DOT is integrating transit into all transportation services. [The] DOT facilitates. [The] TDP becomes an integral piece of this."

Despite the importance of ITS-transit, the stakeholders do not believe that the State and local governments should be investing more in ITS-transit because "the architecture is not in place." Furthermore, a stakeholder said, "Transit operation hasn't formed the process yet. We must form objectives, goals, and initiate measures. Once that happens, we will come to the right funding levels."

The stakeholders thought it was important to merge APTS into the regional ITS architecture. One said, "APTS should, at a minimum, be included in regional architecture." All of the stakeholders also believe that transit should be combined with regional transportation services and traffic operations in a regional Transportation Management Center. On that issue, one stakeholder said, "Communication is important, not co-location."

In general, the stakeholders were not satisfied with the level of public awareness of ITS-transit. One stakeholder indicated that the public was not even aware of transit, let alone ITS-transit. To improve public awareness, they suggested the use of the Internet in addition to more standard methods of communication, such as information at malls. One stakeholder expressed the belief that "transit customers are trapped." Another said, "ITS-transit cannot be a frill. [It] should be able to capture the choice rider."

The stakeholders do see opportunities for public-public and public-private partnerships for ITS-transit. Some of the suggestions for these partnerships included:

- commercialization of transit, featuring "televisions and movies in buses;"
- partnership with fare payment services;
- website with advertising space to sell;
- partnership with Amtrak; and
- partnership with ports and airports.

The benefits of applying ITS-transit in rural areas were said to include "scheduling and dispatching, and electronic fare payment."

The stakeholders had many visions of the future for ITS-transit and lamented the current state of transit in which they are "serving a captive rider." One stakeholder suggested, "Until you have communities with focal points, transit won't be successful." Another stakeholder indicated that there should be "information to make a decision about whether to use a private vehicle or transit." That stakeholder further believes that this information will be available on "a device as small as our cell phones and we can access it by pushing a button." In addition to that, yet another stakeholder stressed the convenience ITS-transit can offer, suggesting "express buses on exclusive lanes. [An] example is Disney. Park your car and they get you everywhere else." A fellow stakeholder echoed those views by saying that, in the future, you should be able to "go anywhere, anytime, and have access to information on how to get there conveniently."

Summary of Central Office Stakeholder Interviews

The Central Office stakeholder meeting was held in the Rhyne Building in Tallahassee on August 11, 2000. A total of six stakeholders participated in the meeting.

The stakeholders believe that APTS is a low priority compared with other ITS activities because of a lack of funding. One stakeholder said, "Finances are running thin," and another added, "Spending is very low on transit right now." However, all of the stakeholders think APTS, given the opportunity, has the ability to improve public transit.

The roles of the "various players" in APTS were also discussed. While the stakeholders mentioned that the roles vary from county to county, they did state that the "MPOs don't participate in rural areas." Those within the FDOT Public Transportation Office were referred to as "gatekeepers." Additionally, the stakeholders agreed that state, local, and transit operations should be investing more in APTS. They also stated that, if work program budget items were to increase ridership, it would be a valuable tool. Overall, the view was one of distributing funds wisely. One stakeholder suggested a course of action that would "dedicate allocation to congestion management, which would lead to funding in transit, then to ITS-transit." Another opinion was that a "flexibility of funding" is essential to avoid boxing in areas.

On the subject of integration, one stakeholder believes that "any time systems can talk to each other, they should." Concerning the topic of ITS architecture, one person said, "People are aware, but the perception is there is no reason why it's not integrated." One stakeholder added, "When stakeholders know what is in it for them, they get excited."

Upon discussing whether transit should be included in a TMC, all of the stakeholders agreed with the statement that, "All transportation modes should be tied together. Virtually or physically, they should be tied together."

The stakeholders also all agreed that there is not enough public awareness for APTS. One suggestion was that "transit needs to take the lead. Give information for hotels and motels to inform visitors that there is a transit system." The stakeholders also mentioned the power of the Internet, suggesting links to all modes of transit and real-time travel information. One suggestion to increase public awareness was to provide information at fairs and other gathering areas for people.

The stakeholders gave many examples of partnership deals for ITS-transit, such as a partnership with local taxi service, a trolley up and down a beach area to reduce traffic, and malls installing variable message signs for transit near the mall stops. Advertising was also seen as a major possibility for partnerships. One stakeholder said that there should be "advertising, but also dissemination of transit information, such as 'The bus arrives in three minutes – drink Coke.'"

The visions of the future for APTS included "a quantum leap in maintenance, operation and information combining various modes." Other suggestions included an integration of service and the production of dependable transit. "Transit should deal with service" was one specific suggestion.

Overall, all stakeholders pointed out the importance of getting information to the users. One final suggestion was to "have a transportation channel, just like the Weather Channel."

SUMMARY OF RURAL STAKEHOLDER SURVEY

In order to gain the perspective of rural transit providers, a survey based on the questionnaire utilized for the stakeholder meetings was distributed to Community Transportation Coordinators (CTCs) throughout Florida with the assistance of the Florida Commission for the Transportation Disadvantaged. The survey sought to assess the CTCs' perceptions of APTS and to determine the applications that are the most widely used and/or may be the most beneficial in the rural areas of the state. Fifteen rural agencies responded to the survey. Agency respondents are listed in Appendix D.

The survey results echo the results of the initial APTS inventory survey and the findings from the stakeholder meetings that were held. The rural participants are familiar with ITS, as well as the more specific APTS. Most of the respondents believe that ITS could have a positive impact on effectiveness and that, if affordable, ITS could "offer a tremendous benefit." One respondent noted that "within 10 years, ITS/APTS will significantly restructure public transportation and blur the current distinction between transit and paratransit." Further, most of the respondents (specifically, 11 of 15) believe that APTS is "equally important" as other ITS applications. Similarly, most of the respondents believe that it is very important that APTS be integrated into the regional ITS architecture and that transit should be combined with regional TMCs. Interestingly, while in the minority, two of the respondents expressed reservation over the integration of transit into TMCs. The first noted that, eventually, the integration should occur, but not initially. A second participant said that such integration may be appropriate in the urban setting, but not in a rural one.

When asked whether APTS would improve the performance of public transportation, the respondents are split between APTS offering "some improvements" and "significant improvements." Of those respondents that identified the possible benefits of APTS to rural areas, most cite cost effectiveness and efficiency as the greatest benefits. Specifically, one rural stakeholder believes that APTS will allow greater definition of flexible route potentials; while another believes that communication between rural counties will be improved and transit "feed-lines" to urban areas can be created.

Of the fifteen responding rural agencies, less than half are promoting or deploying APTS applications. Those applications being used or considered are scheduling and fleet management software, AVL, and electronic fare payment technologies. Most of the respondents either could not describe the level of APTS in their respective areas or considered it to be low or poor. According to the survey participants, the impeding factors to more widespread use of APTS are related to costs and funding, as well as needs assessment and reluctance of transit systems and CTCs to accept change or embrace technologies. To respond to these impediments, the respondents recommended that more information on the "financial advantages" of APTS be developed and shared to reduce the reluctance to accept the applications. Further, one participant recommended that rural or small transit systems be granted "price breaks" or "tax incentives" when choosing to deploy APTS. To address the impediment of unwillingness to embrace technologies, one respondent recommended that APTS applications be more user-friendly and that they are designed to be "ready-to-go" at installation.

When asked to define the role of the various players in the development and deployment of APTS, many of the responding agencies agreed that FDOT has several opportunities to facilitate deployment on the local level. Some of the respondents alluded to the need for FDOT to address its funding distribution process and assist with consensus building and cost effectiveness analysis. While not assigned to a particular transportation entity, other crucial tasks in the development and deployment of APTS that were identified by the respondents include educating the public and elected officials of the benefits of APTS, developing a standard architecture, providing recommendations, and assisting with training.

Over half of the respondents believe that it is important to seek funding for APTS and that state and local government should invest more in APTS. The respondents most often identified state and local government as the funding sources for their APTS projects; specifically identifying Section 5307 or Service Development funds.

None of the responding rural stakeholders were satisfied with the level of public awareness for APTS (two did not answer the question and one did not feel knowledgeable enough on the subject to answer). When asked what appropriate methods of increasing public awareness might be used, the participants mentioned disseminating information through local agencies, mail-outs, public workshops, marketing campaigns, successful demonstrations, and media coverage.

Regarding Bus Rapid Transit, most of the respondents agreed that it should be integrated into the surface transportation system. Specific features of BRT that were appealing to the survey respondents were vehicle location systems, low-floor buses, multi-bus strategies, and electronic fare collection. However, one of the stakeholders noted that determining which of these features should be incorporated into BRT should depend on the local agencies needs and desires rather than determined by central planning organizations.

Finally, the survey queried the rural stakeholders on how APTS can be made to be more effective in Florida. Some of the survey respondents indicated a belief that Florida's rate of growth and high transportation demands will necessitate APTS. Others responded with specific ways to ensure the effectiveness of APTS, such as through recruiting innovative field practitioners of new technology, having one architectural standard, introducing it first to major urban areas, and conducting trial and error demonstrations.

Summary of Rural Florida ITS Demonstration Project

According to the Rural Florida ITS demonstration project reports available on the Internet at http://www.dot.state.fl.us/ctd/fl-its.htm, this project applies ITS technology to selected rural areas of Florida's coordinated transportation system. (Information used in this summary is taken from the project's *Year-End Report* and *First Quarter Report of 2000*.) The project deals with transit service offered to the transportation disadvantaged, providing transport for employment or health related trips. Three rural areas in northeast Florida (Flagler, Putnam, and St. Johns Counties) were given $60,000 each for start-up. Two counties (Alachua and Marion) were later added to the project when additional funding was awarded by FTA.

The various ITS technologies that were used included Geographic Information Systems (e.g., MapInfo), Global Positioning Systems (GPS), mobility management software (e.g., RouteLogic), and other electronic applications, such as e-mail and internet access.

Although problems did occur in the early stages of development, once a uniform architecture was established (called a "Memorandum of Understanding" [MOU], formalized in late 1998), it gave all parties involved the guidelines needed to move forward.

The technologies involved did cause some problems, although most seemed to stem from incompatibility problems with outdated hardware. Once upgrades were performed, the technology operated well. Additionally, it was indicated that all staff understood how to operate the technologies. Those involved with the project have indicated that it has helped develop efficient transportation for citizens.

The rural areas participating in this program and their experiences with ITS are discussed in summary fashion in the following sections.

Flagler County CTC

Flagler County Transit (FCT) is Flagler County's Community Transportation Coordinator (CTC). FCT primarily has been working with RouteLogic, an off-the-shelf transportation management software package developed primarily for routing and scheduling purposes. Since the beginning of the pilot project, FCT staff has shown the ability to pick up the technology quickly. Their understanding of the project's goals and what enhancements would be necessary to meet those goals has been a major factor in the project's success thus far.

Working with the RouteLogic vendor, FCT has been developing various reporting and billing enhancements to the product that would ensure that the software would meet *Florida-based Reporting* requirements. In fact, the working relationship has gone so well that FCT was used as the *beta test* site for all upgrades and modifications to the software, and even hosted a "Users Group" forum for users from around the U.S. Because of the attention the ITS project has brought to RouteLogic from the state and federal level, all of the enhancements to the product were developed quickly at no additional charge to the users. (It should also be noted that the technical team also has been using the GIS software package, MapInfo, to develop various reporting templates.)

Interestingly, the work that went into enacting FCT's transition to the RouteLogic software has helped spur the development of the staff. Various staff members are now providing on-site technical assistance to other users and presenting on ITS technologies at national conferences. FCT also contracted with St. Johns County Council on Aging Transportation Section in 1998 to assist in that agency's initial start up and conversion of RouteLogic. Additionally, FCT is providing staff training and on-site technical assistance to the Alachua and Marion County CTCs (new participants in the Rural ITS project).

Overall, FCT has been operating very efficiently and has had few service problems. ITS technology has provided greater system stability and has facilitated the more efficient scheduling of resources. A future goal is to use the automated scheduling feature of the software to analyze route efficiencies, with the intention of establishing fixed service routes (in order to shift away from the costlier demand-response mode). Additionally, it should be noted that, as a result of their experience, the FCT technology team believes that the AVL technology may not be as important to their service delivery function as they once thought.

Putnam County CTC

The Putnam County CTC (known as the "Ride Solution") is the transportation section of the Putnam County Association of Retarded Citizens. This particular CTC has been recognized as being a pioneer in rural technological and operational advancements over the last few years. As a result, the Ride Solution took a different approach in its participation in the Rural ITS project from the other two original participants.

Ride Solution already had a proprietary routing and scheduling program in place that had been developed for them by a consultant. However, since the system was based primarily on a service route delivery model, staff believed that they needed Automated Vehicle Location (AVL) technology installed on their vehicles. This technology would enable them to track schedule compliance and to gather data for client and driver tracking, vehicle maintenance, mileage calculation for billing, and further analysis of the service routing component. (It should be noted that, despite its desire to pursue a different direction, Ride Solution did install a RouteLogic workstation to be able to interface with the other participants for the coordination of inter-county trips.)

The identification, purchase, and installation process for the AVL equipment turned out to be significantly more difficult and frustrating than RideSolution anticipated. The system originally gained approval to "piggy back" on a Request for Proposal (RFP) process for AVL equipment that had been initiated for an Iowa Department of Transportation ITS project being managed by the consultant who developed RideSolution's transportation management software. Unfortunately, Ride Solution staff had reservations about the unanimously-selected vendor's product. Ultimately, the system identified a suitable product, manufactured by CSE (an Orlando-based company), and, after dealing with some competitive procurement issues, contracted with the company in December 1999. Installation of the AVL units was scheduled to take place in March 2000.

Overall, the Putnam County system has also been operating very efficiently, with very few day-to-day service problems. Nevertheless, management has expressed serious concern over schedule compliance, since on-time performance is key to operating in a service route environment. It is anticipated, however, that the new AVL technology will help address this problem and ensure quality service delivery.

St. Johns County CTC

St. Johns County Council on Aging, Inc., is the county's CTC; its Transit Division is known as St. John's County Transit (SJCT). A review of the system in April 1998, near the beginning of the Rural ITS project, showed that SJCT was having serious operational problems. There had been a significant turnover in operations and management staff, and the new Executive Director was seriously concerned with the system's efficiency and financial stability. Two major problems impacting the system at this time were its facility (all eight staff members were crammed into one small room) and the lack of adequate transportation management software. All staff responsibilities were shared (no distribution of tasks) and the administration of the service was extremely paper intensive, with most functions being completed by hand.

Since that time, though, SJCT has undergone a dramatic changes. The major restructuring began in January 1999, when the transportation department moved from its original one-room operations center that was housed within the CTC's building, to a renovated house adjacent to the CTC. The new facility was upgraded with computer cabling, modifications to the electrical system, and new phone lines. Even the way that the office runs has evolved, as well. Only one of the eight original staff members remains and new staff has been hired with more clearly delineated roles and responsibilities. The CTC even hired Flagler County Transit's Operations Manager to serve as Assistant Executive Director (this individual has been particularly instrumental in SCJT's transition to ITS technology).

The RouteLogic software was installed in December 1998, prior to SCJT's move. Despite a new Windows NT-based server and hardware upgrades to the existing workstations, numerous lockups occurred. This was due to the fact that SJCT's original workstations (i.e., low-end Pentiums) were too outmoded, even with the upgrades, to accomplish the applications required by the software. ITS Expansion grant funding, however, made it possible to replace the workstations, which then solved the scheduling/mapping lockup problems that had been occurring.

Interestingly, solving the computer woes led to the stabilization of the system's scheduling function, which solved another problem SJCT had been having: drivers dictating their available hours. This had been making scheduling difficult and inefficient. However, with the ability to consistently schedule runs, SJCT management was better able to make driver scheduling decisions that were in their best interests, rather than letting the "tail wag the dog."

Overall, SJCT staff has found that the introduction of technology has resulted in driver costs per trip going down significantly. In addition, the system now is able to schedule more people at less hours and use cost-saving techniques such as split shifts. Vehicle time has also been reduced. Even the billing of services has been streamlined from a paper-intensive process to a quicker, computer-based methodology that utilizes geo-coding to calculate trip mileages.

Despite the successes that have been experienced to date, SJCT is still having some problems with Medicaid billing (i.e., a significant amount of information must be re-inputted each month for all of the Medicaid-related trips). This issue should be taken care of soon, however, by an integrated Medicaid billing interface that is being developed for the software. In addition, SJCT believes that additional training is needed for the software, especially for the many reporting and query functions. Because of these functions and the many enhancements that are added to the software with each version upgrade, SJCT staff believes that the vendor should develop a step-by-step instruction book, so that users can quickly troubleshoot problems and train fellow staff.

It should be noted that, at the time of the *Year-End Report*, SJCT's AVLs were not active and needed to be expanded to improve the functionality of the system. According to that document, this will be a primary focus of the second phase of the grant.

Alachua-Levy Counties CTC

Coordinated Transportation System, Inc., (CTS) is the designated CTC for Alachua and Levy Counties. This CTC was selected to participate in the Rural Florida ITS Demonstration Project when the project was expanded in October 1999. Installation of the RouteLogic software occurred in November 1999, and CTS acquired Internet and e-mail capabilities shortly thereafter in December. Prior to implementation of the software, CTS staff were trained, client files were converted, and address information in the system's database was cleaned.

CTS went "live" with the RouteLogic software on January 1, 2000. Unfortunately, service became very disrupted for the riders due to repeated omissions of scheduled rides and the lack of city references on the manifests, which resulted in a large number of late appointment deliveries. To solve these initial problems, CTS updated all of its client files with city information and also had two additional staff members cross-trained in the scheduling function to provide more support.

According to CTS, the implementation period was extremely busy, but the peer training received from Flagler County Transit (both on-site and at FCT) and the additional problem-resolution insight from the Marion County CTC proved to be very beneficial. The addition of extra staff was also helpful to them, especially since the transition to RouteLogic turned out to be much more involved than they had anticipated. Despite these problems that were encountered, however, CTS still believes that the change has merit. (It should be noted that CTS was not using AVLs at the time of the report.)[1]

Marion County CTC

The Marion County CTC was the other CTC that was selected to participate in the Rural Florida ITS Demonstration Project when the project was expanded in October 1999. Prior to implementation of the RouteLogic software, the Marion CTC updated all of its computer equipment and its networking software in November 1999. The RouteLogic software was then installed between November and December 1999. The vendor provided on-site training during this time for Marion staff, who also received orientation training for the software at the Flagler County Transit offices.

The Marion CTC experienced some difficulties during the implementation stage because of delays in the procurement, installation, and training process. Data entry, driver training, and community information activities that had been planned had to be curtailed. A two-week transition period using manifests from both the new and original systems was scrapped since on-line scheduling with the

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[1] Interestingly, it is important to further note that, on October 1, 2000, ATC/Intelitran was designated as the new CTC for Alachua County. Since ATC/Intelitran has developed and sells its own mobility management software, RouteLogic did not want a competitor to have direct access to its product. As a result, ultimately it was decided to retrieve all equipment and property from CTS related to the demonstration project and install it in two smaller, more rural counties (Baker and Union) near the general service area of St. Johns and Putnam Counties.

RouteLogic software began on January 3, 2000, and the original system was not Y2K compliant so it could not accept appointments in 2000. Instead, staff and driver memory had to be utilized in conjunction with the new manifests in order to complete trips during the first week of implementation.

Other problems that Marion staff have had to deal with include the lack of driver training and Medicaid billing issues. Because of the initial delays, official training for drivers did not occur. Thus far, training for the drivers has been one-on-one as manifest are produced and problems or questions arise. In addition, Marion has had to utilize its old system for Medicaid billing due to some data reading issues that have delayed the conversion to direct billing from RouteLogic.

Because Marion County CTC was in the very initial stages of implementing the software when their report was filed, there is not a lot of information on their experiences in dealing with it. At the time of the *Year-End Report*, AVLs had not been utilized and no coordination of trips had occurred. However, it was indicated that the Marion staff did receive (and were very appreciative of) considerable cooperation in orientation, training, and the answering of questions from the other project participants, Flagler County especially.

Project Summary

In conclusion, the Rural ITS Demonstration Project is significant because it deals with a number of the issues that will arise once ITS-transit is implemented across the state. Despite its relatively small scale in terms of available APTS technologies, the project shows that concerns involving technology do, indeed, have some validity. However, it also proves that they can be overcome, especially with a high level of coordination and support between those involved in its implementation (i.e., the agency, the State, and the vendor). Furthermore, the project shows the value of a system-wide architecture plan for agencies to follow, and the importance of funding to provide any hardware upgrades needed to run the technology. As for the overall value of the technology that is being utilized, one conclusion of the Rural Florida ITS demonstration project First Quarter Report for 2000 is that, while the technology does present some issues, the participating CTCs definitely see merit in the change.

SUMMARY OF CHAPTER ONE

This first chapter in the Inventory and Analysis of Advanced Public Transportation Systems in Florida document has summarized the results of two surveys that were administered to the 30 state block grant-receiving transit systems in Florida (an initial APTS inventory survey and a follow-up survey), a number of APTS stakeholder interviews with FDOT senior management staff and others, and a rural stakeholder survey of CTCs in the state. It has also presented a current synopsis of the Rural Florida ITS Demonstration Project.

The findings from the initial inventory questionnaire revealed that, for most transit agencies, the majority of the ITS-transit technologies that the agencies will be utilizing are currently in the planning stages. Advanced communications and automated paratransit are the most popular technologies, with 14 transit agencies either in the planning, implementation, or fully operational stage. Other popular technologies include automated operations software (12 agencies), trip planning information (12), and single-mode and/or multimodal trip planning information (11). Interestingly, every one of the APTS technologies that were discussed in the questionnaire currently is being utilized, or will be in the near future. Nevertheless, it should be noted that high occupancy vehicle lane access is the least popular technology among the transit agencies that responded; only two systems indicated using or planning for this technology. This is not a surprising outcome given the lack of exclusive, barrier-protected HOV lanes in Florida.

As for the actual deployment of APTS technologies, the advanced communication technology is the most frequently deployed technology being utilized by the transit agencies that responded to the survey. Nine agencies currently have advanced communications systems in operation. Automated fare payment also has significant levels of deployment among the respondents: six agencies have operational automated fare payment systems in place at this time.

The results of the follow-up questionnaire showed that, according to the responding transit agencies, service effectiveness is the primary motivation (with safety being a secondary motivation) for the implementation and use of ITS-transit technologies. However, the vast majority of the responding transit agencies also indicated that the cost of APTS and/or the lack of funding is the key factor that currently impedes the deployment of ITS-transit. In fact, this was cited as the primary reason why so little ITS-transit was currently implemented. According to most of the respondents, funding is essential for any progress with APTS to be made, especially if the goal is to make ITS-transit more effective in Florida.

In addition to the importance of providing funds for ITS-transit activities, the transit agencies also believe in the importance of establishing an overall architecture (whether regional or statewide) to which all individual ITS-transit projects should conform. It was indicated that it is equally important that this particular architecture conform to the national ITS architecture, as well. Within the specific architecture, then, the individual APTS projects can be integrated at varying levels contingent upon the actual technology being deployed. Many of the agencies also stressed the value of ensuring equipment compatibility within varying levels, again based on the particular technology.

In discussing the various technologies that the responding agencies had implemented thus far, it was determined that the performance ratings of the technologies are quite good. Most only indicated a desire that their specific technologies could do even more (e.g., vehicle component monitoring system also keeping track of brake and seatbelt usage). Only one agency indicated a "poor" rating and, based on staff comments, it is evident that the rating has more to do with the vendor of the electronic signs that it is utilizing, and not the technology itself. Overall, the responding agencies seem to be quite pleased with the experiences with ITS-transit technologies, thus far.

Despite the relative successes that have been achieved to date, it still is apparent to the transit agencies that funding is not the only obstacle that must be overcome. It is believed that a lack of awareness among the transit agencies about how to use technology is a potential stumbling block to deployment. In addition, agency staff indicated that the level of public awareness for ITS-transit improvements is still extremely low. This is also the case for public officials, as well. One of the major benefits of ITS-transit is that it can improve transit service for current passengers in a host of ways and make it more attractive for non-users, too. However, if people are unaware of the benefits, how will the desired results of increased ridership and a broader passenger base be achieved? Without this awareness, then, the relatively large investment required for APTS technology deployment may be for naught.

Fortunately, the agencies' vision for the future includes a belief that ITS-transit is"very important and will happen." While they acknowledge that the impact of APTS has been relatively moderate at best, so far, the agencies are positive that ITS-transit's future impact can be increased through a variety of important activities such as securing funding, planning, education, marketing, establishing partnerships, and monitoring performance (versus established standards for each technology). Communication will also be key as agencies will need to "compare notes" and share successes with each other as more APTS technologies are deployed and more lessons are learned.

From the various stakeholder meetings, it is apparent that a majority of the persons that were interviewed consider ITS-transit to be very important. They also indicated that technology advancements in transit did indeed warrant funding, especially given the potential to improve transit and attract new riders. But, it was also cautioned that the deployment of APTS should be "planned and managed," even prioritized–it would be folly to simply "throw money at it." To ensure the success of ITS-transit in Florida, it also was stressed by a number of participants that the State's ITS architecture should conform to that of the national ITS architecture and that "all systems [should] be interchangeable." This means that, to the extent possible, all technology should conform to the established statewide architecture, be integrated, and have compatible equipment.

Interestingly, the stakeholders did express concern with the application of APTS to transit because of transit, itself. That is, because transit has such a low level of demand and awareness from the public, it is believed that ITS-transit, although helpful and efficient, will not be able to solve the root of the problem–namely, that not many people have the need or desire to utilize transit. Nevertheless, most of the respondents do believe that ITS-transit–with the proper funding–can have success in attracting discretionary riders back to transit. As an example, real-time information was suggested as being one of the tools that could be useful in "self-marketing" ITS-transit while increasing the attractiveness of transit. While its impact has not been felt as of yet, the stakeholder interviews seem to indicate that traditional transportation professionals believe ITS-transit has the potential to revolutionize transit.

Some of these same sentiments and issues were echoed by the rural stakeholders in their survey responses. According to a number of CTCs in the state, certain APTS technologies should be tremendously beneficial to rural transit and help tie much of their paratransit service to the fixed-route systems in urban areas. Some of the more applicable technologies being used or considered by the rural transit providers are scheduling and fleet management software, AVL, and electronic fare payment. However, the rural stakeholders see a number of impediments that still must be overcome to make the use of APTS in rural applications more widespread, such as technology costs and insufficient funding sources, lack of public and elected official awareness, and the need for training, among others. Regardless, though, the rural stakeholders see APTS as an eventual necessity for transit given Florida's continuing growth and the burgeoning demand for transportation and mobility.

Finally, the brief review of the Rural Florida ITS Demonstration Project illustrated a number of issues that will arise as ITS-transit activities continue across the state. As various technologies are implemented, it can be expected that problems will occur related to training; the procurement, delivery, and installation of new equipment; the obsolescence and/or compatibility of existing equipment; maintenance; and actual operation, among other issues. However, the demonstration project was also helpful in showing that many of these concerns can be overcome, especially with a high level of coordination and support between all parties involved in its implementation. The project also showed the value of a system-wide architecture plan for agencies to follow, and the importance of funding to provide any hardware upgrades needed to operate the technologies being implemented. Lastly, the project also exemplified the usefulness of one particular ITS-transit application, i.e., transportation management software, and the benefits that it has brought about for several rural transportation providers.

CHAPTER TWO

ISSUES & CHARACTERISTICS OF THE DEVELOPMENT/DEPLOYMENT OF APTS: A LITERATURE REVIEW

INTRODUCTION

The examination of 10 major APTS development and/or deployment issues and characteristics experienced by transit agencies in Florida and throughout the country is the task that is described in this second chapter. As noted previously, the development and deployment characteristics of APTS that are examined herein include:

- level of conformity with national (and soon to be developed Florida) ITS architecture;
- institutional arrangements needed for multi-modal and inter-modal connectivity;
- available funding sources;
- procurement methods of APTS products and services;
- impacts on agency operation, maintenance staffs, and budgets;
- extent of public-private and public-public partnering;
- extent of general public involvement;
- integration into regional transportation services and systems;
- application to rural areas and/or demand responsive service; and
- extent and sophistication of benefits analysis (prior to deployment) and performance monitoring (following deployment).

This chapter investigates these ten characteristics as they relate to the experiences that transit agencies have had to date in their efforts to plan, implement, test, and/or operate any variety of APTS technologies. The primary source of information for this examination is a literature review of reports, on-line documentation, and other pertinent information available at the time of the data collection effort for this task (i.e., December 2000). The list of references utilized for this review is presented in Appendix E. In addition, the follow-up APTS inventory survey results that were presented in the first chapter are used, along with supplementary information drawn from the findings of the stakeholder meetings and the initial inventory survey, to examine the APTS experiences of the Florida transit agencies as they relate to these issues, as well.

APTS Development/Deployment Characteristics

As discussed in the introduction, this chapter will examine 10 particular issues/characteristics related to the development and/or deployment of APTS technologies, and synopsize how they have impacted the APTS implementation efforts of transit agencies in Florida and throughout the U.S. Again, the specific APTS characteristic categories include:

- ITS Architecture & Conformity
- Institutional Arrangements
- Funding
- Procurement
- Operation & Maintenance
- Partnering
- Public Involvement
- Regional Integration
- Rural Applications
- Benefits Analysis & Performance Monitoring

The following sections discuss each of these characteristics and provide general overviews for each based on readily available literature. Florida transit agency-specific opinions and/or experiences based on the results of the follow-up APTS inventory survey also are included as available. The goal is to provide a status report of APTS in Florida based on an analysis of each of the above issues/characteristics in the context of a broader ITS perspective.

ITS Architecture & Conformity

The Intermodal Surface Transportation Efficiency Act (ISTEA) of 1991 identified a particular need for compatibility among the various transportation technologies that were being implemented throughout the U.S. Because of this need, a program began in September 1993 to develop a National ITS Architecture. Ultimately, a national standard for ITS was completed in June 1996, with the specific intent of unifying a host of interrelated user services (e.g., public transportation management, emergency management, traveler services information, etc.) and promoting guidelines to ensure the "seamless" deployment and operation of ITS across the country.

"The National ITS Architecture was developed to provide a unified framework and building blocks that agencies can use to create an integrated ITS strategy that meets the needs of a particular state or region."

–excerpted from *Benefits of Integrated Technologies and the National ITS Architecture*, John A. Volpe National Transportation Systems Center, Policy and Technology Analysis Division, August 1998

In general, a system architecture is a model that describes how the particular components of the system will interact to achieve the system's goals. This model defines the operation of the system, the operation of each component in the system, and the information that is exchanged between the components. This type of "blueprint" is beneficial especially for larger, more complex systems like ITS. Fortunately for the individual agencies planning for or implementing any ITS technologies, however, system *architecture* does not mean system *design*. While it may have an influence on design, the architecture leaves the specifics of system design (e.g., technologies, vendors, institutional arrangements, deployment approach, etc.) up to the individual agencies. Instead, it provides guidance and facilitates the development of standards. The availability of such a framework has also been found to help minimize system costs by ensuring sensible deployment and streamlining design (e.g., minimization of equipment redundancy).

The expectation for the National ITS Architecture is that it will more easily enable ITS deployment throughout the U.S. that is characterized by efficiency, economies of scale, and national interoperability. The goal of "national interoperability" basically seeks the establishment of a system that is compatible nationwide and links all modes of transportation. One of the primary tools the architecture will use to meet this and other goals is national standards and protocols development. While a number of standards/protocols have already been created, many others are still in different stages of development and are not yet complete. Some of the primary standards related to ITS-transit are as follows:

- National Transportation Communications for ITS Protocols (NTCIP);
- Transit Communications Interface Protocols (TCIP);
- Dedicated Short Range Communications (DSRC) protocol; and
- Vehicle Area Networks (VAN).

As it specifically relates to transit and APTS, it is anticipated that these and other standards, as well as the rest of the architecture's framework, will allow transit agencies to better plan and design their APTS projects and deployment methods to meet their immediate needs, while still providing them with the flexibility to accommodate future system expansion and/or integration. In addition to the technical assistance that it provides, the architecture even documents a series of analytical tools (e.g., cost/benefit, risk assessment, communications) that can be utilized in planning for regional deployments. It should also be noted that the systems engineering approach that the architecture recommends for implementation includes an evaluation step that encourages post-deployment assessment of the application(s) to generate quantifiable information on costs, performance, and benefits, as well as to determine the degree to which project objectives were met.

> ***"The Transportation Equity Act for the 21st Century (TEA-21) contains a provision requiring Intelligent Transportation Systems (ITS) projects implemented with funds from the Highway Trust Fund (including the Mass Transit Account) to conform to the national architecture [National ITS Architecture], applicable or provisional standards, and protocols."***
>
> –excerpted from *Interim Guidance on Conformity with the National ITS Architecture and Standards*, U.S. Department of Transportation, October 2, 1998

Unfortunately, the mere presence of a national architecture will not necessarily guarantee that ITS deployment throughout the U.S. will be seamless and interoperable. For this reason, the U.S. Department of Transportation (U.S. DOT) has tied "conformity" with the National ITS Architecture to funding in an effort to ensure agency compliance. (It should be noted that, although "conformity" is specified in the TEA-21 language, the U.S. DOT believes that the term "consistency" better reflects its intent. Nevertheless, U.S. DOT uses the terms interchangeably for this purpose.) The U.S. DOT even developed an Interim Guidance document to "[promote] sound systems planning and design practices for ITS projects" and "to ensure that ITS projects meet the legislative intent."[2]

But what does "conformity" actually mean for those agencies seeking to implement ITS technologies? According to the *ITS Deployment Guidance for Transit Systems Technical Edition* (which utilizes the synonymous term, "alignment"), it means "using the National ITS Architecture framework as guidance in designing and deploying systems."[3] This particular definition and the discussion of conformity in

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[2] *Interim Guidance on Conformity with the National ITS Architecture and Standards*, U.S. Department of Transportation, October 2, 1998, http://www.its.dot.gov./aconform/iguide.htm.

[3] Interestingly, a recent policy change has defined conformance with the National ITS Architecture as the "development of a regional ITS architecture within four years after the first ITS project advancing to final design, and the subsequent adherence of ITS projects to the regional ITS architecture." This new definition comes from the FTA National ITS Architecture Policy on Transit Projects that became effective on February 7, 2001 (*Federal Register, 23 CFR Parts 655 and 940, Intelligent Transportation System Architecture and Standards, Final Rule*, U.S. Department of Transportation, Federal Transit Administration, Vol. 66, No. 5, January 8, 2001). The basis for this policy, which requires that the regional architecture be based on the National ITS Architecture, is the belief that it is improbable to expect a single metropolitan area or State to fully implement all aspects of the National ITS Architecture.

other architecture-related documentation can be interpreted similarly: agencies should simply review and understand the architecture's guidelines and processes, and use them as necessary to ensure that their projects comply with the ultimate goals of this effort. Again, it is not a step-by-step design that must be followed precisely–it is an open and flexible framework that provides direction. For example, when an agency plans the implementation of a particular ITS subsystem or device, the concept of national architecture conformity would mean that the subsystem or device would:

- support some subset of the functions defined for that subsystem/device in the national architecture;
- support the data flows relevant to the included functions defined for that subsystem/device in the national architecture; and
- use open interface system standards, as available, to ensure ability to communicate with other subsystems/devices, upgradeability, and future expandability.

"The challenge of meeting Florida's transportation needs is a daunting one. ITS offers a new set of tools for meeting these needs"

–excerpted from *Florida's Intelligent Transportation System Strategic Plan, Final Report*, Florida Department of Transportation, August 23, 1999

In Florida, the growing importance of applying technology to help meet the State's increasing transportation needs has spurred the FDOT to develop a Statewide ITS Strategic Plan. According to the plan, its purpose is "to guide the Department, Florida Metropolitan Planning Organizations, and local governments in the planning, programming, and implementation of integrated multi-modal ITS elements to maximize the safety and efficiency of Florida's Transportation System." In addition to recommendations involving the establishment of Department and District ITS Programs, staff and training requirements, and ITS procurement processes, among others, the plan also seeks the development of a statewide ITS architecture (to be based on the national architecture), along with supporting standards and specifications. It is expected that bringing this framework down to the state level will stimulate and facilitate the development of ITS programs, strategic plans, and architectures and standards at the regional and local levels, as well.

Although most of the ten Florida transit agencies that responded to the follow-up APTS inventory survey have not been following the progress of the statewide architecture project (only two indicated doing so to any degree), the majority agree that it is very important for individual ITS-transit projects to fit into an established overall architecture. And, according to most of the respondents, it is preferable that this architecture be statewide in scope. Further, there is some belief among the responding agencies that the Statewide ITS Strategic Plan will prove to be helpful (four of the five agencies responding to this question indicated that it was a good idea and could help), especially as it relates to the deployment of APTS technologies.

As for alignment with the established architecture, it is apparent that the responding agencies are open to the idea of conformity and would find guidance for the deployment of APTS beneficial. When asked to define the concept of conformity, several of the respondents provided the following thoughts:

- "user integration;"
- "integrated, intermodal transit system;"
- "various components can communicate with each other;"
- "standardization;" and
- "integration, coordination, needs (for efficiency)."

From these responses, it is evident that these agencies realize and support the importance of standardization and integration in APTS deployment. In fact, almost all of the responding agencies believe that it is important for APTS to be merged into the regional ITS architecture. Unfortunately, the agencies did not offer many ideas for how this can be accomplished. One agency suggested "mak[ing] it a standard; standardize systems," while another believes it would be best to do so "through [the] state DOT." Regardless of how APTS ultimately fits in with the regional or statewide architecture, the agencies were in agreement that it will be important for this architecture to conform to the national architecture.

Institutional Arrangements

The deployment and operation of ITS technologies, especially at the regional or statewide level, often can involve a host of agencies, organizations, authorities, jurisdictions, and/or governmental entities. Typically, the greater the geographic coverage and/or complexity of the implementation, the greater the number of entities that must be involved and coordinated. For example, the deployment of a vehicle component monitoring system on board the vehicle fleet of a local transit agency may only require the involvement of the agency itself, or perhaps that of a few departments of the municipality in which it operates (depending on the transit agency's organizational structure and requirements for funding, board approval, procurement, etc.). However, a signal priority system to optimize traffic flows and provide priority for transit and emergency vehicles will expand the number of entities that must be involved (e.g., local government, State DOT, traffic operations, police, emergency services, transit agency, local news media, etc.). Involvement and coordination can become even more complex as the deployment crosses multiple jurisdictions (e.g., a statewide or regional commercial vehicle operations system or a corridor incident management system).

> ***"The responsibility for managing traffic in most metropolitan areas has evolved over time in response to public needs, resources, and prevailing institutional and political arrangements. Within each political jurisdiction these managerial responsibilities are often dispersed among separate public agencies. If cooperation is lacking, this fragmentation will inhibit chances for the successful implementation of certain elements of the national ITS program."***
>
> –excerpted from *ITS Strategic Deployment Plan, Final Report*, prepared by HNTB, TRW, and TEC, for the Ohio Department of Transportation - District 12, April 1996

According to much of the ITS literature, institutional coordination has become one of the more important, and challenging, issues in the implementation of ITS projects. Without cooperation between agencies involved in the deployment of a particular ITS application (often referred to as the "stakeholders"), the implementation, operation, and management of the technology will be difficult, and it may not have a chance to reach its full potential. But what makes coordination and cooperation so difficult? The literature raises a host of reasons, ranging from jurisdictional issues to the lack of ITS-specific technical expertise among transportation professionals. Some of the more widely-acknowledged, and experienced, impediments to coordination are introduced and briefly discussed below. Given the number and variety of issues that can arise, it should be noted that those presented herein have been grouped into a few broad categories for simplicity's sake.

Interagency Issues - One of the largest categories of coordination impediments involves the various issues that can arise among agencies participating in the implementation of a specific ITS technology. For the most part, agencies that typically would be involved in an ITS deployment have had relative autonomy in their respective decision-making processes. However, the centralized nature of many ITS applications (e.g., advanced traveler information system, advanced traffic management system, commercial vehicle operations, etc.) necessitates a level of cooperation and coordination that many of these agencies may find difficult to fully accommodate because of their inherent differences.

It may be the case that the agencies have different agendas, with operational philosophies and priorities that differ or, worse, conflict. The respective functional and/or organizational cultures of the agencies also can have a significant effect on coordination efforts. For example, the agencies may operate, or be responsible for, different modes; they may also have independent/diverse revenue sources, oversight boards, political accountability, and, perhaps, even legislative restrictions. This is especially the case when a deployment requires the involvement of both public and private entities (see subsequent section on Public-Private Issues).

Further compounding the problem are lack of proper inter-agency communication and poorly-defined agency roles. The distinct functions and agendas of the agencies can become even more divergent if each of the agencies involved does not know or understand its overall role and responsibilities in the deployment effort. Therefore, it is important to institute clearly-defined roles for each of the participating agencies at the outset. Properly identified and established lines of communication are also essential in ensuring a clear understanding of agency roles, the dissemination of correct and consistent information to all partners, and, ultimately, the successful completion of the deployment.

Jurisdictional Issues - As noted previously, the number of coordination impediments can often multiply as the deployment crosses jurisdictional boundaries. The interagency issues remain the same, but they are magnified due to the increased number of stakeholders that must be involved and coordinated. And, as the number of participants in a deployment increases, so does the likelihood of organizational, functional, and/or operational differences among them. It is certain that cross-jurisdictional deployment will also require significantly higher levels of intergovernmental cooperation, as well.

Consider the example of an Advanced Traveler Information System (ATIS). One particular interagency issue revolves around the ownership and control of data – both the data required for the operation of the ITS technology and the information that results from it. If LYNX and the City of Orlando decided to implement ATIS within its immediate metropolitan area, this data-intensive application would certainly raise data control/ownership issues among the participating agencies (most likely to include LYNX, local government, traffic operations, police, emergency services, local toll authority, media, etc.). Now, consider how the data issue would escalate if a similar system were implemented along the I-4 Corridor between Orlando and Tampa. The participating agencies would increase in number and be even more decentralized in terms of responsibilities, jurisdiction, etc. Unfortunately, the success of the ATIS application, which is predicated on the centralization of its operation, could be jeopardized if a logical plan for how to handle the data function is not established, agreed upon, and followed by all stakeholders.

"In tailoring the framework provided in the National ITS Architecture to local needs, agencies must work together to decide what information is needed, how it will be collected and maintained, and when different agencies have access to or control over information."

–excerpted from *Transportation Planning and ITS: Putting the Pieces Together*, prepared by Sarah J. Siwek & Associates for the Federal Highway Administration, U.S. Department of Transportation, April 1998

Public-Private Issues - Coordination issues that can occur when public and private entities are involved jointly in the implementation of an ITS application are interagency, in nature. However, they can be somewhat more problematic because of the significant differences in the cultures and priorities of the public and private sectors. Generally, private agencies are market driven; profit is an important motivating factor. Conversely, the public sector is driven by the various rules and regulations that have been established at the local, State, and Federal levels.

This basic difference is evident in one of the primary issues that emerges when public and private entities engage in ITS deployments: the commercialization of the technology's products and services. For example, consider the sale of traffic data. According to the literature, in many cases, public sector restrictions limit or prohibit the sale of traffic information. However, private agencies involved in ITS projects that would utilize and/or produce this type of information would surely seek to capitalize on its availability. This would be a motivating factor for their involvement since it would be possible to profit from their initial investment in the venture. Without this opportunity, many private agencies may not want to commit to participating in ITS deployments because of their lack of confidence in the deployments' ultimate profitability.

Another issue that must be considered when coordinating public-private relationships involves the development of proprietary technology and the intellectual property rights associated with it. Similar to the case for the sale of traffic data, proprietary technology can be a significant motivating factor for private agency participation, especially since research and development costs can be offset through the sale of the ITS technology or service. This issue needs to be addressed at the outset of any agreements, though, because of the Bayh-Dole Act, which assigns the rights of inventions from federally-funded projects to the Federal Government. In addition, a related public-private relationship issue that should be considered involves anti-trust legislation. Specifically, a government agency must be cautious in establishing a relationship with a private company to ensure that an inequitable arrangement is not made that could harm the private entity's competitors or taxpayers. Fortunately, the National Cooperative Research and Production Act of 1993 was enacted to provide a measure of protection to agencies collaborating for the purpose of research. Finally, it is generally believed that the time lag that can occur from an initial ITS project concept to its full deployment is an issue that also can impact continuity in private sector participation.

Technical Capability Issues - One interesting concern in coordinating the implementation of ITS technologies is the increased level of technical skills that often is required to be involved in such deployments. With advanced technologies comes the need for a greater "technical understanding of information, communications, and computer technologies, as well as the design and installation of new ITS technologies and applications and their integration within existing 'legacy' systems."[4] Unfortunately, previous deployments have shown that the current engineering knowledge of many of today's transportation professionals is not enough. In order to ensure the success of future ITS deployments, professional capacity in ITS-related topics must be increased. Professionals at both public and private agencies that will be involved with such deployments will need to build their expertise in communications, electronics, systems integration, and automation technologies, as well as improve their basic computer skills. In addition, it will be extremely important that they keep their skills and knowledge up-to-date given the expected continual evolution of ITS technologies and innovations.

While there appears to be many impediments to the successful coordination of participating agencies involved in the implementation of an ITS technology, it must be remembered that a large number of deployments of varying scale have already taken place throughout the U.S. Many have been successful both because of an awareness of the potential pitfalls and a dedication to overcome them through careful planning and stakeholder cooperation. Among the ITS literature, there are a number of documents that have reviewed previous deployments or interviewed principal stakeholders to determine the keys to their coordination successes, as well as the reasons behind their setbacks. In fact, one document, *Saving Lives, Time and Money Using Intelligent Transportation Systems: Opportunities and Actions for Deployment*, provides suggested actions for many different stakeholders (e.g., state governments, MPOs, transit agencies, academia, etc.) that may be involved in an ITS implementation. Several of the more widely-documented recommendations are bulleted below.

- Establish a general vision or plan for ITS and transportation that encourages a regional outlook.

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[4] *Building Professional Capacity in ITS: Documentation and Analysis of Training and Education Needs in Support of ITS Deployment*, U.S. Department of Transportation, ITS Joint Program Office, ITS PCB Program, April 1999.

- Identify and enlist a wide range of stakeholders, including those that may be somewhat non-traditional (e.g., emergency response teams, academic institutions, major employers, etc.), and ensure their involvement in the ITS planning process and their agreement on and support for the ITS vision/plan that is ultimately adopted.

- Promote activities that necessitate varying levels of interagency coordination for other purposes, such as conducting regional planning studies or sponsoring training programs that can be attended by state and local transportation officials, as well as other stakeholder representatives.

- Encourage the emergence of a "champion" organization or convene a "cross-cutting" task force to serve as a facilitator for bringing stakeholders together and coordinating them. Interestingly, several documents suggest MPOs as the ideal forum for coordinating regional ITS activities. With a transportation planning process structure in place that already incorporates 3C (cooperative, comprehensive, and coordinated) planning, outreach, and public participation, the MPO "is being viewed as an effective mechanism to facilitate and coordinate ITS planning, across modes, across political and functional boundaries, and between public- and private-sector organizations."[5]

- Develop an ITS operating concept that clearly delineates the stakeholders' roles and responsibilities during the development, implementation, and operation of the system, as well as the interagency communication structure that will be utilized throughout the process. The operating concept should also include an implementation plan that both supports and allows sufficient time for interagency involvement.

"There are many stakeholders that will play a part in the deployment, operations and management of ITS in Florida. Stakeholders include both public and private sector participants. The successful participation of these stakeholders in Florida's ITS program requires two things: organization and outreach."

--excerpted from *Florida's Intelligent Transportation System Strategic Plan, Final Report*, Florida Department of Transportation, August 23, 1999

As ITS technologies continue to be implemented throughout Florida, it is expected that many of the same institutional coordination impediments that are being experienced elsewhere in the U.S. will be encountered here, as well. Fortunately, the FDOT is aware of many of the issues and has included a

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[5] *Nontechnical Constraints and Barriers to the Implementation of Intelligent Transportation Systems, Update of the 1994 Report to Congress*, U.S. Department of Transportation, Federal Highway Administration, Joint Program Office for Intelligent Transportation Systems, Washington, D.C., 1997.

number of action items in Florida's ITS Strategic Plan to help ensure that they are appropriately addressed. For example, the Plan calls for the development of a model and process for stakeholder involvement at the statewide, regional, and individual project levels. The intent of this action is to ensure efficient working relationships among stakeholders and maximize their ability to provide input. Other related actions include the formation of a statewide ITS stakeholder advisory committee, the development of a private sector outreach initiative, the implementation of a statewide ITS training program, and support for coordination with public transportation ITS activities.

In the follow-up APTS inventory survey, while a section was not included that specifically addressed the topic of institutional arrangements, there were several survey questions that touched upon issues related to this topic, including coordination and stakeholder roles, and a few others that engendered responses that also discussed similar issues. For example, one of the survey's general questions asked the respondents about the factors that have impeded the deployment of APTS. Among the transit agencies' responses were several issues that have been discussed previously as being widely-experienced impediments to coordination and deployment: communication issues, lack of knowledge/expertise on the part of the implementing agencies, and lack of sufficient time to properly plan and coordinate the deployment.

In discussing the roles of the various "players" in the development and deployment of APTS, a few of the responding transit agencies indicated that education is an important need. A number of the respondents also stressed the importance of the involvement of FDOT's Central Office, as well as its District offices, during the development and deployment process. One of the respondents indicated that local government also needs to be more supportive of and involved in APTS activities. In addition, it was mentioned that MPO involvement could help, as well, especially with the education process and data collection and retention.

Interestingly, these ideas coincide quite well with a few of the issues that were discussed previously in this section. In fact, in responding to a question on the activities that are necessary to ensure and maintain the success of APTS, the following were provided by the participating transit agencies: education, planning, communication, awareness, partnering, and sharing successes. These are all recommended keys to the successful planning, implementation, and operation of ITS technologies, as identified in much of the literature. Therefore, it would appear that many of the Florida transit agencies are aware of the issues that they may encounter as they attempt to implement new technologies and coordinate stakeholders during the process. Fortunately, they also will have the Florida ITS Strategic Plan to assist them in their efforts. The Plan should have an additional benefit, as well: seven of the ten responding transit agencies indicated that they believe the Plan will encourage more coordination for ITS projects.

Funding

The federal legislature recognized the importance of ITS and the role that it could play in the advancement of transportation efficiency when it introduced ISTEA legislation in 1991. Through ISTEA, state and local jurisdictions were specifically encouraged to use federal funds to support the research, planning, and operational testing phases of ITS deployment. Through TEA-21, possible-funded activities were expanded to include the support of capital as well as operations and maintenance costs of ITS transit projects. As a result, more ITS projects have become eligible through federal funding mechanisms.

Inevitably, successful ITS deployment is directly related to many functions, including the ability to identify, secure, and utilize funds. Unfortunately, the advancement of ITS is often constrained by the complicated organization of the funding options available to local jurisdictions and will greatly depend upon the ability of the federal government and state jurisdictions to clarify the funding alternatives so that more local agencies are encouraged to solicit funds for innovative ITS technology.

The various federal funding programs that may be used for ITS are numerous. However, some sources may be restricted for operational testing or other phases of deployment. Federal flexible funding sources such as National Highway System (NHS) funds, Surface Transportation Program (STP) funds, Congestion Mitigation and Air Quality (CMAQ) funds, and Interstate Maintenance (IM) funds all have been made available for projects, including ITS research, development, operational testing, and operation and maintenance. The Federal Highway Administration (FHWA) is authorized to allocate ITS Integration funding, which is a dedicated source that provides assistance solely for the integration of ITS components.

For NHS funds, infrastructure-based ITS capital improvements are eligible activities. STP funds may also be used for projects involving infrastructure-based ITS capital improvements, as well as for other capital costs for transit projects, highway and transit research and development, and technology transfer programs. CMAQ funds may be used for transit (new system/service and expansions or operations). Transportation activity in an approved State Implementation Plan and those projects involving public/private partnerships and initiatives also may qualify for CMAQ funds. ITS integration funds can be used to accelerate ITS integration and interoperability in metropolitan and rural areas. In metropolitan areas, funding is primarily used for *integration* of previously deployed or soon-to-be deployed ITS components. In rural areas, funding may also be used for installation costs.[6] A primary step for any transit agency seeking federal funds for ITS projects must be to determine project eligibility under the various federal funding programs and to seek additional funding sources to assist with the probable shortfall. While the number of funding programs for which ITS projects may be eligible has grown, the funding levels remain extremely limited and acquisition of these funds require that state and local jurisdictions identify alternative funding sources, such as public/private partnerships.

> ***". . . the state DOTs and MPOs must choose between ITS/CVO [commercial vehicle operations] and competing demands for the obligation of these [federal aid highway] funds. Key planning and budget staff in these agencies often have limited familiarity with ITS/CVO. In addition, because the mandate and organization of ITS/CVO programs are still developing in many states, ITS/CVO often takes a back seat to more traditional big-ticket items such as highway and bridge construction and maintenance . . . ."***
>
> –excerpted from *ITS/CVO Funding Strategies for States*, Federal Highway Administration, March 1998

In addition to sifting through federal funding alternatives, transit agencies must often deal with "difficult tradeoffs and choices between investing in infrastructure improvements, ITS initiatives, and/or a combination of both."[7] Many states and local jurisdictions, when faced with choosing between innovative, but unfamiliar, ITS initiatives and typical system improvements, more often than not pursue funding for the usual infrastructure because they are not familiar enough with the benefits of ITS to champion deployment initiatives to the public and the people most responsible for placing a priority on such projects. While, these agencies may suspect that specific technologies would provide benefit, they are not able to translate that benefit into *definable* measures of safety, efficiency, and cost savings. In addition, the relatively new presence of ITS projects compared to the inundated backlog of traditional infrastructure improvements provides further incentive for the prioritization of the typical projects over the ITS initiatives. Consequently, the low ranking of ITS deployment projects by state and local jurisdictions make federal funds acquisition more difficult to achieve. Until the dissemination of benefits data between the users and potential users of ITS is consistent and the barrier of unfamiliarity is overcome, transit agencies will continue to be poorly-equipped to successfully advocate for funding.

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[6] *Fact Sheet on FY '01 ITS Deployment Program*, attachment to press release, *U.S. Transportation Secretary Slater announces $93.9 million in grants for Intelligent Transportation Systems*, Federal Highway Administration, November 2, 2000, http://www.fhwa.dot.gov/pressroom/itsfact.htm.

[7] *Florida's Intelligent Transportation System Strategic Plan, Final Report,* Florida Department of Transportation, August 23, 1999.

Through organized attempts to establish national, regional, and state ITS architecture, ITS deployment slowly is becoming better recognized as a viable and effective tool for advancing efficiency in transit. Its acknowledgment among state and local transportation agencies has grown and ITS deployment has benefitted from such advocacy.

> ***"Statewide and district deployment will not only require an increase in funding for equipment and infrastructure, but also for training and operations and maintenance."***
>
> –excerpted from *Florida's Intelligent Transportation System Strategic Plan, Final Report,* Florida Department of Transportation, August 23, 1999

In response to the financing constraints to ITS deployment, the FDOT and the State of Florida has taken on a more proactive role by initiating activities that would identify it as a contender for funding of ITS projects. The development of the Florida ITS Strategic Plan is one step toward solidifying the FDOT's role in the successful deployment of ITS technologies across the state. The Strategic Plan addresses the need for increased funding for ITS training, operations, and maintenance, and establishes the objective of developing FDOT District ITS resources to encourage more local participation.

A further indication that FDOT is cognizant of the funding constraints for ITS technology is the candid conversations during the stakeholders' interviews. In particular, the FDOT stakeholders acknowledged the funding problems and their concerns seem to compliment the findings of the follow-up APTS inventory survey. According to the results of the survey, most of the respondents identified costs or funding as an impediment to APTS deployment. The follow-up survey results also indicate that all of the responding Florida transit agencies believe that providing funds for APTS in public transportation projects is "very" important, and that it is "somewhat" to "very" important to seek funding for APTS.

It was more difficult, however, for the respondents to identify the percentage of the budget that should be allocated to APTS. One transit system indicated that one percent of the agency's budget and five percent of the state's budget should be allocated for this purpose, while another system indicated that two percent of each respective budget would be appropriate. Two other systems suggested budget percentages that ranged from 10 to 15 percent. Unfortunately, a number of the respondents could not identify what percentage of the budget should be allocated to APTS. It may be the case that this results from the unfamiliarity of many transit agency personnel with the costs and benefits associated with the deployment of such initiatives – an unfamiliarity, consequently, that can impede APTS deployment.

As for funding sources that have been used by Florida transit agencies thus far, the survey results seem to suggest that the responding agencies rely very little on private or innovative funding techniques for APTS deployment. Only one responding agency indicated using private funds, while another indicated the use of Florida Toll Revenue credit. Most acknowledged, however, that a mix of federal, state, and/or local funds were used for their respective projects.

Overall, the opinions of the responding Florida transit agencies and the stakeholder participants were quite similar. There seems to be a general recognition of the need to actively seek funding for APTS and of how doing so might significantly improve transit efficiency. However, the actual source of that funding and how APTS deployment will fare against traditional needs in current and future budgets is less agreed upon.

Procurement

The procurement of ITS technologies can be complicated and is worthy of extensive consideration in the overall process of deployment. ITS proposals are rarely best served by traditional procurement practices. Instead, the technological complexity and the need to adapt to the constantly evolving applications require that the procurement mechanisms be flexible to minimize institutional barriers to ITS deployment.

> ***"The traditional procurement process for construction of a facility involves the letting of and completion of two separate contracts; one [for the preparation of] detailed design specifications, and . . . another for construction of the facility. . . . This traditional approach utilizing a bifurcated process often lacks the flexibility required when contracting for rapidly evolving technologies and systems such as ITS."***
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> –excerpted from *Executive Summary of Innovative Contracting Practices for ITS*, prepared by L.S Gallegos and Associates, Inc., for the Federal Highway Administration, April 1997

Traditional procurement practices were originally developed to support the design and construction of infrastructure or to facilitate the purchase of equipment, such as vehicles. However, these practices present disadvantages in ITS acquisition by not allowing enough consideration for technology, discouraging those who operate and maintain the ITS technology from participating in the procurement process, and not facilitating multi-agency or private/public partnership or collaboration.[8]

There is a recognized need for procurement to be standard in most situations, especially when "standard" is thought to be synonymous with "fair" or "equitable." This is why the sealed low-bid

[8] *ITS Deployment Guidance for Transit Systems*, *Technical Edition*, U.S. Department of Transportation, Federal Highway Administration, April 1997.

process is most often used for traditional transportation infrastructure projects. The low-bid process, however, requires that well-defined functional and/or performance-based specifications be established at the outset of the project with little, if any, room to account for adjustment. ITS products and services generally utilize technologies that produce data that are independently useful, but are infinitely more useful when multiple applications are integrated. Consequently, those transit agencies with little or no operational/management experience with the specific ITS application proposed to be deployed may find it difficult to establish defined specifications to allow for future complex integration of systems and will risk losing innovative insight and solutions that are dismissed in the low-bid process.

> ***"This perception [that ITS projects must always use the same procurement approach required for construction projects] has resulted in numerous procurement disasters where the 'normal' low-bid procurement process has been inappropriately used for ITS projects. We must be more proactive in dispelling this perception . . . ."***
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> – excerpted from a memorandum by Anthony R. Kane, Executive Director, ITS Joint Program Office, Federal Highway Administration, October 6, 1999, http://www.its.dot.gov/procure/memo-a.htm

Most federal authorities now acknowledge that flexible procurement procedures are required due to the complexity and quick evolution of ITS technologies and they are encouraging state and local jurisdictions to use competitive negotiation methods after conducting qualifications-based selection procedures. In addition, some jurisdictions have begun to experiment with innovative procurement methods. In 1990, the FHWA established Special Experimental Project No. 14 – Innovative Contracting Practices (SEP-14), which enabled transportation agencies to implement contracting practices that maintain the advantages of competition while enhancing project quality and timeliness to the procurement process.[9]

Another disadvantage that typical procurement procedures pose for ITS projects is the requirement to maintain autonomy in the process. Most states prefer that agencies keep the procurement function independent of those who will operate and maintain the system. *ITS Deployment Guidance for Transit Systems* suggests that this practice exists to ensure that public funds are "properly expended and efficiently managed." However, the complexity of many ITS technologies and the necessity of the systems to be integrated or interoperable demand that technical advice and its responsible consideration be included in the decision-making process. When such advice is ignored, for instance

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[9] *FHWA Federal-Aid ITS Procurement Regulations and Contracting Options*, Booz Allen & Hamilton, U.S. Department of Transportation, Federal Highway Administration, Turner-Fairbank Highway Research Center, October 1997.

to save money, the agency risks employing technology that is quickly approaching obsolescence or fails to integrate with existing systems, thus, precluding optimal efficiency.

In response, some transit agencies are making adjustments to procedures by adopting a team approach that includes, in addition to the purchasing personnel that typically may be involved in procurement, technical personnel that will be involved in the deployment of the ITS applications. Technical advisors are able to comment on technological needs while purchasing advisors outline budget, financial, and procedural restrictions that impact the type of technology or service to be procured. In cases where personnel lack the experience in ITS to provide useful assistance to the procurement process, establishing procedures to allow review by neighboring agencies with more experience may be a viable option. Either situation provides an opportunity to balance procedural and technological interests in the process.

Also, many successful ITS deployments have involved interagency or multi-jurisdictional cooperation. In areas where multiple transit agencies operate, the potential for regional compatibility and interoperability of ITS technology is great. However, institutional barriers associated with interagency cooperation often discourage the consideration of embarking on truly integrated ITS deployment. In *ITS Deployment Guidance for Transit Systems Technical Edition,* it is suggested that the lack of defined roles and responsibilities, difficulty in reconciling policies and procedures, and incompatible procurement regulations most often discourage intergovernmental agreements. To circumvent these problems, the authors recommend that "agencies adopt broad grants of power to perform activities necessary and incidental to the accomplishment of an agency's mission." They also recommend that the parties enter into intergovernmental agreements in state agency enabling legislation.

> ***"The Florida experience, particularly in the areas of initial procurement, operations, and maintenance, clearly reveals a need for statewide procurement policies and standards for systems architecture and equipment, which FDOT is in a unique position to provide. "***
>
> –excerpted from *Florida's Intelligent Transportation System Strategic Plan, Integration of ITS into the MPO Transportation Planning Process Issue Paper,* prepared by TEI Engineers and Planners for the Florida Department of Transportation, February 1999

Like most states, Florida most often utilizes the low-bid (Engineer/Contractor) procurement process for traditional transportation infrastructure projects. Through the ITS Strategic Plan, FDOT reiterated the advantages and disadvantages of the traditional procurement process. In addition, FDOT acknowledged in the plan that there are many local agencies who have yet to experience initial ITS deployment and that there exists a need for further guidance from the State on selecting the most appropriate and effective procurement process. In the meantime, the MPO planning process has been identified as an effective forum for state and local governments, public officials, private stakeholders, and interested citizens to discuss ITS procurement policies and experiences and, further, to arrange for better interagency cooperation.

In the *Procurement Issue Paper* for the Strategic Plan, organizational and procedural restrictions to public/private partnerships were identified as a limitation of procurement processes in Florida. The paper noted that several states have passed legislation to allow public agencies to "accept partnership proposals from the private sector, with limited or no competition, provided there is clear public benefit from the arrangement." In the paper it was suggested that Florida would benefit from such opportunities.

The follow-up APTS inventory survey afforded the transit agencies the opportunity to identify the procurement methods that were used for the APTS applications they currently have in place or are implementing. While only a few identified a particular procurement method, the bid system appeared to be used most often. Advanced Communication Systems, for most of the respondents, were purchased through a countywide or multiple-agency contract. Lack of local expertise was identified as an impediment to APTS advancement and this issue probably impacted the earlier phases of the projects, such as specification development and procurement. The transit agencies seem content with using those practices with which they have the most experience and are most comfortable. Perhaps as more innovative procurement procedures are practiced in Florida and as the state considers developing new procurement vehicles, as was suggested in the *Procurement Issue Paper*, more agencies will associate with procurement practices that are better suited for ITS technology.

Operation & Maintenance

The operation and maintenance tasks associated with successful ITS deployment are detailed and can be costly. If, prior to purchasing a particular APTS application, a transit agency has not thoroughly planned the application's integration into the system's overall current and projected planning schemes, the system will surely face unexpected delays, costs, and other setbacks. To ensure proper operation, management, and maintenance of ITS applications, the implementing agency will be best served if, first, an operations and maintenance plan is developed. Obviously, an agency must develop its operations and maintenance plan with its particular goals and limitations in mind; thus, every plan will differ. However, all plans should address, at a minimum, staff requirements and responsibilities, thorough training and support, and scheduling and procedural requirements for response and preventative maintenance. Each plan should also address financing issues, such as costs associated with operations and maintenance and funding opportunities that are eligible to be used for these activities.

A major aspect of an operations and maintenance plan should be to address staff requirements and responsibilities. This task obviously is determined by the various applications utilized by the agency developing the plan. In general, APTS-related literature suggests that automated vehicle location (AVL), advanced communication systems, and computer-aided dispatch (CAD) are the most utilized APTS technologies by transit systems. The nature of these particular applications reduces the manual responsibilities of agency staff and provides efficient and reliable methods of data collection and storage. The operational staff needed for most APTS applications is the existing dispatch and data collection employees, when provided with additional training. According to a study by the Federal Transit Administration, not only did necessary fleet size decrease after implementing CAD, but the number of dispatch staff required dropped by 50 percent for most of the reviewed agencies, and dispatch staff were completely eliminated by one taxi company.[10]

Unless an agency has had a great deal of experience with similar applications, most do not employ the staff readily capable of installing the APTS technologies. Instead, the installation of APTS applications is often done by the vendor or is included in the specifications for new vehicles, when possible. Staffing requirements for maintenance procedures is more complicated, however. The agencies have several staffing options for maintenance, which include vendor provided or supplied, contract maintenance with a third-party, or in-house maintenance provisions. These options generally apply to software APTS applications. However, when transit applications depend on shared infrastructure another option might be maintenance agreements with the partnering affiliates.

It is anticipated that, as APTS is implemented and improved operating efficiency is demonstrated, there will be a reduction in the number of operators needed to provide the same number of passenger trips. In addition, as fewer vehicle miles per trip are generated, maintenance requirements may occur less frequently, thus, reducing the maintenance staff requirements. When the operations and maintenance plan is developed, it should identify current staffing requirements and project those requirements for several periods, including within a few months of integration, at prescribed intervals of adjustments (such as three, six, and twelve months), and following a preestablished evaluation period. Throughout, an agency may have to modify its projected staff requirements as it finds the APTS applications meet, exceed, or fall short of their expectations.

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[10] *Personalized Public Transit*, ITS Decision report, http://www.path.berkeley.edu/~leap/PTO/Personal_Pub_Transit/index.html, last update: November 7, 2000.

Also included in an agency's operations and maintenance plan should be specific strategies for training the staff in implementing and maintaining the APTS applications. It is not uncommon for transit agencies to purchase APTS software only to have it sit unused because the staff is not trained or is reluctant to utilize it. If ITS is to continue its momentum in public transportation, the educational and training needs and requirements must be addressed. On the local level, an agency can begin by prescribing a training program and support system for its staff so that they can become experienced enough with the applications to recognize when they can and/or should be integrated with other technologies so that the greatest benefits are extracted.

According to *Building Professional Capacity in ITS: Documentation and Analysis of Training and Education Needs in Support of ITS Deployment*, the key questions of a plan might be (1) ***who*** needs to know about ITS?; (2) ***what*** fundamental knowledge or skills are essential to operate and maintain ITS activities?; and (3) ***how*** are the skills best learned?[11] An agency's operations and maintenance plan should address each of these key questions. First, addressing *who* needs to know about ITS will involve determining the staff required to effectively operate the technologies, as previously discussed. The roles and functions of each of those staff persons should then be identified so that the "what," or competencies, needed to perform the job effectively can be identified. Finally, once it is known who will be needed and what they will need to know, the agency must determine the best way to attract workers with those particular skills and build and maintain those skills in existing staff.

Building Professional Capacities in ITS included the results of surveys conducted with various transportation entities, including transit agencies. The purpose of the surveys was to determine how the agencies were involved with ITS, what types of staff were needed to perform ITS tasks, what they needed to know, and how staff are trained for those roles. Typical ITS projects identified in the survey by transit agencies were deploying and operating transit AVL systems and automated trip planning systems, as well as operating transit data management systems. The survey results also suggested that transit agencies believe that the ideal team would include project managers, operators, dispatchers, and maintenance technicians and supervisors skilled in some form of ITS technology. While some roles may require specialized levels of knowledge, for others it may be necessary only to have a basic "awareness of the general framework." The results also identified training and education needs for ITS personnel. Those most relevant to transit include systems integration, technology options, data analysis and management, software and hardware operations, and systems support and maintenance. The best methods for delivering these skills in these areas to the appropriate staff can be achieved in several

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[11] *Building Professional Capacity in ITS: Documentation and Analysis of Training and Education Needs in Support of ITS Deployment*, U.S. Department of Transportation, ITS Joint Program Office: Washington DC, April 1999.

ways, including traditional classroom training, job rotation or exchange programs, certificate programs for continuing education, peer-to-peer networks, and vendor-sponsored programs. In an agency's operations and maintenance plan, a matrix might be developed identifying the who, what, and how of ITS education, training, and support.

Another major function of an agency's operations and maintenance plan should be to address procedures for response and preventative maintenance. Efficient maintenance procedures will allow a transit agency to effectively react to emergency failures, maintain accurate records, and conduct preventative maintenance so that the life-cycle of the applications are extended. The document, *Florida ITS Strategic Plan: Operations, Management, and Maintenance Issue Paper*, suggests that a life-cycle cost analysis be conducted "to compare using higher priced components in order to reduce regular maintenance costs."[12] This would be an excellent task to accomplish for consideration *prior* to the development of an operations and maintenance plan.

In general, the plan should address what procedures will be required to maintain the ITS technologies employed by the agency. It must also identify the maintenance-related roles of the staff. Maintenance for transit-related ITS components differs from the maintenance requirements of traffic and freeway management systems. Depending on the size of the transit agency, failure with just a small fraction of its assets could disrupt service throughout the entire system. The maintenance requirements for traffic and freeway management systems are better documented and much more readily available among peers, while experience with required maintenance cycles for transit-ITS has not been well-documented. There are, however, some similarities in maintenance requirements that will allow transit agencies to make safe assumptions about their requirements. For instance, traffic signal preemption technologies are integrated with the traffic systems operations and maintenance and transit systems may be able to adopt maintenance requirements similar to, or in cooperation with, the traffic management systems.

> ***"In areas of rapid technology change that are subject to significant pricing variations, like communications and computer systems, special attention should be directed to updating the strategy."***
>
> —excerpted from *Florida ITS Strategic Plan: Operations, Management, and Maintenance Issue Paper*, Florida Department of Transportation, June 6, 1999.

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[12] *Florida ITS Strategic Plan: Operations, Management, and Maintenance Issue Paper*, Florida Department of Transportation, June 6, 1999.

In its operations and maintenance plan, a transit agency should estimate costs associated with response and preventative maintenance, staffing requirements, and training and support requirements. Again, these costs are highly dependent upon the types of APTS technologies deployed and whether these activities are performed in-house, by contract, through partnerships, or by other means. The plan should also address estimated costs for replacement, not only for inoperable components but also to account for technology advancement and the replacement of obsolete components.

Transit agencies must also explore, as it estimates costs and builds a need for increased funding, all possible funding sources. No one source is capable of completely meeting the funding needs of ITS operations and maintenance. In fact, after taking full advantage of federal sources such as STP, NHS, IM, and CMAQ funds, an agency will still need to rely on local sources, partnerships, and revenue opportunities for supplementary funding.

FDOT has established, through the ITS Strategic Plan, several goals which address its role in the operations and maintenance of ITS in Florida. They are:

- The Department should develop an ITS Operations Manual. Each district will adapt the policies and procedures to their requirements.
- Each district should develop ITS staff requirements and a training program that will enable them to meet the ITS services they plan to deliver over the next five years.
- Each district should assess staff resources to determine which, if any, operations and maintenance functions are appropriate for outsourcing.

If these goals are achieved, the resulting statewide or district-wide benefits (statewide manual, district-wide training program, and available outsourcing support) will assist state transit entities immensely. It will provide another resource to which transit agencies can refer in an area that is still unfamiliar to most. The lack of available resources on education, training, and "real-life" experiences is a concern to transit agencies in Florida. The respondents to the follow-up APTS inventory survey suggested that the education and support from FDOT districts is key. The respondents seem to agree that transit agencies are looking for a lead from the FDOT Central and District Offices with regard to training and organizing the dissemination of information among APTS participants.

Partnering

A successful ITS program often requires cooperation between the public and private sectors. Hence, as the implementation of ITS technologies has become more widespread, a variety of partnerships have been formed between public-sector and private-sector entities, as well as intergovernmentally. The fast-track development, deployment, and operation of an ITS program usually relies on and can benefit from combining the strengths of each sector. While intergovernmental cooperation will help to alleviate standardization issues, public-private partnerships typically allow for innovative procurement and financing approaches. With encouragement, cooperative partnering will build the new ITS technology infrastructure for the 21st century and accomplish milestones.

> ***"The Implementation Strategy of the ITS Architecture identifies a public-private partnership as 'an attitude leading to cooperation and trust and a productive working relationship with tangible benefit to each of the partners.' The implementation strategy views the public sector as implementers, operators, and maintainers of traffic, transit, and emergency management systems. The private sector will invest in and market private consumer products, such as vehicle navigation and traveler information units and collision avoidance technologies."***
>
> -excerpted from *Nontechnical Constraints and Barriers to the Implementation of Intelligent Transportation Systems*, 1997 Update, U.S. Department of Transportation, Federal Highway Administration, Joint Program Office for Intelligent Transportation Systems, Washington, D.C., 1997

The U.S. DOT has made a concerted effort to bring state and local governments, academia, and the private sector together in order to conduct basic and applied research, field testing, and deployment support. The U.S. DOT believes that, in order to successfully implement ITS technology, the transportation sector should promote cooperation among all potential partners. In fact, consortia have been organized to provide a forum for potential partners, such as manufacturers, ITS suppliers, universities, and state governments. Intergovernmental cooperation and public-private partnerships can yield gains, such as cost sharing, functional standardization, and interdisciplinary teams. In order to gain these benefits, the federal government especially has tried to encourage the private sector to play a larger role in advancing APTS technology.

According to the report, *Transportation Planning and ITS: Putting the Pieces Together*, private sector involvement may take a number of forms: users, suppliers, franchisees, and information service providers. While these partnership arrangements promote a variety of advantages, legal and institutional issues associated with public-private partnerships, and even with intergovernmental cooperation, must first be resolved in order to gain the full benefit of partnering. It was indicated in the document, *Public and Private Sector Roles in Intelligent Vehicle-Highway Systems (IVHS) Deployment*, that there are five major public-private partnership barriers that hinder APTS technology implementation:

- unwillingness by the public sector to share management responsibilities with the private sector;
- jurisdictional fragmentation;
- legal constraints;
- procurement and contracting regulations; and
- uncertainty of the market for IVHS technology.[13]

It is important for agencies considering partnerships of any kind to account for and seek to address these potential pitfalls prior to and during the partnering process to avoid disagreements, delays, or other problems, and to ensure that the experience is ultimately advantageous to all parties involved. A 1993 federal study declared that, "although public-private partnerships are cost effective, and allow the public to benefit from private firms' expertise in developing, marketing, deploying, and maintaining new products, difficulties in the formation of public-private partnerships have delayed field operational tests an average of six to twelve months."[14] Interestingly, many of the early APTS technology partnerships encountered such delays. Most resulted from issues that arose due to the inexperience of the agencies involved. Another causal factor was that the competing motivations between the public and private sectors were not dealt with appropriately. Hence, dividing responsibilities between the different stakeholders was problematic. Unfortunately, rather than enhancing the advancement of ITS technology, these initial dysfunctional partnerships decreased its effectiveness by increasing project costs and time delays.

To address public-private organizational, philosophical, and/or jurisdictional differences, planning is key. Procedures and agreements need to be delineated at the outset of the partnering process. Public-private partnerships require innovative management; therefore, a management procedure should be established that will emphasize each of the partner's responsibilities for fulfilling planned, as well as unforeseen, project tasks. This will help to avoid unnecessary confusion. Moreover, a liaison between the parties could be utilized to monitor the project schedule and ensure that all parties are fulfilling their duties.

Further, it would be wise to ascertain the desired goals of a public-private partnership before formulating any contractual agreements. In a perfect world, private funding and expertise would help provide innovative solutions at a lower cost to the taxpayer. However, this scenario is likely to occur

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[13] It should be noted that a number of these and other related issues were introduced and discussed previously in the Institutional Arrangements section of this document.

[14] Belair, Robert R., Alan F. Westin, and John J. Mullenholz, *Privacy Implications Arising from Intelligent Vehicle-Highway Systems*, paper prepared under Federal Highway Administration Contract No. DTFH61-93-C-00087, December 8, 1993.

only when each sector's needs are met. The experiences of many of the early public-private partnerships have shown that the greatest conflicts occur due to an innate difference in philosophies between the public and private sectors. While both respond to their respective stakeholders, each sector follows a different set of rules. Public sector organizations work in a political environment, requiring the efficient use of taxpayer dollars. In contrast, private companies are profit-driven and must be accountable to their shareholders' wants. Therefore, a suitable contract would balance the private sector's profitability standards with the public sector's "public good" needs.

In order for a public-private partnership to be effective, then, the contractual agreement should account for the participants' respective structures, needs, and strengths. Since private firms utilize profitability goals, the projected arrangement must support an adequate return on investment. The private sector will be more willing to risk its resources when contractual arrangements support the advancement of new business opportunities (e.g., intellectual property rights, commercialization of ITS technology-derived products and services). On the other hand, the public sector will want to be able to utilize ITS technology – and its resulting products – in as many ways as possible for the good of its constituents, without limitations or excess costs (e.g., copyright fees) being imposed for that use. It is the belief of the public sector that the ability to benefit from the use of the intellectual property resulting from any ITS implementation is a fair and appropriate return for the investment of its taxpayers. Ultimately, this often proves to be one of the most difficult issues in which to strike the proper balance to suit both sectors.

> ***"A successful ITS deployment partnership must support not only public objectives, such as reduced congestion and increased safety, but also private objectives, including recovery of development costs and profitability. In general, the basic infrastructure to support private investment must be implemented through public investment before the private sector will become involved."***
>
> -excerpted from *Nontechnical Constraints and Barriers to the Implementation of Intelligent Transportation Systems*, 1997 Update, U.S. Department of Transportation, Federal Highway Administration, Joint Program Office for Intelligent Transportation Systems, Washington, D.C., 1997

The federal government has acknowledged these barriers to partnering, but it also has recognized the progress that has been made to date in public-private partnerships. According to several federal studies, the advantages of partnering greatly outweigh the disadvantages. Some advantages include sharing costs, obtaining expertise through interdisciplinary teams, decreasing the time between development and deployment, and standardizing equipment and data collection procedures. These advantages have impelled the U.S. DOT to dedicate resources for researching and developing best practice methods in order to further strengthen the partnerships between private and public entities (e.g., decreasing regulations imposed upon private firms that partner with public organizations, beneficial tax arrangements, standardized contracts).

It has also helped that agencies increasingly have seen the benefit of sharing their partnering experiences with others. This has enabled agencies considering a partnership to learn from both the successes and the problems that others have already experienced. For example, the Georgia Department of Transportation initiated a project to install 130 advanced traveler information kiosks throughout the State of Georgia prior to the start of the 1996 Summer Olympic Games that were held in Atlanta.[15] During the kiosk deployment process, several important lessons about establishing public-private partnering were learned and disseminated:

- it is often impossible to utilize traditional advertising or other labor intensive revenue sources for projects with a short development time frame;
- each potential partner's willingness to provide funding should be considered when pricing partnership levels; and
- the value of the project to each partner must be established, substantiated, and emphasized.

Besides public-private agreements, partnering can also involve agreements between multiple government agencies. Unlike public-private partnerships, however, intergovernmental relationships are easier to maintain. First, government agencies typically abide by similar missions and guiding principles. Second, state and local groups are used to working with each other on a variety of other issues, including transportation. Therefore, most public-public relationships already have a long-term trust factor that many public-private partnerships lack. The mutual understanding and trust found within intergovernmental relationships usually results in contractual formation taking less time and involving fewer issues. However, it is important to understand that problems between government agencies can and do occur, as well. Typically, these problems result from jurisdictional disputes, payment mechanisms, and project management issues.

A number of case studies show that the successful development and deployment of ITS technology also can benefit significantly from productive partnering arrangements between government agencies, regardless of whether they are at the federal, state, and/or local level. While the federal government promotes implementation guidelines and has begun to create legislation that promotes ITS technology

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[15] Pohlman, James M., and Elizabeth N. Williams, *Public/Private Partnering for the Georgia DOT Advanced Traveler Information Kiosks*, Proceedings: Intelligent Transportation Society of America 6th Annual Meeting and Exposition, Houston, TX, April 15-18, 1996.

usage, local-level problems should be addressed by community-specific ITS technology enhancements. Usually, locally-based projects are able to utilize resources more effectively because they are closer to a community's particular problems and, hence, are better equipped to make decisions. Although projects containing local input have a better chance at resolving a community's transportation issues, local governments need to overcome nearsighted, community-centric behavior.

Beyond highlighting the need for intergovernmental cooperation at the local level is the importance associated with local communities interacting and developing regional ITS technology plans together. This interaction is the best way to ensure that all ITS technology will be interoperable and continuous. Moreover, for the same reasons, state and local governments need to work together to establish ITS technology standards. Standardization among communities will hopefully provide citizens with more beneficial and convenient products. For instance, a standard transit passenger smart card technology could be implemented across a region (or even statewide). This would enable passengers to be able to ride the vehicles of all the participating transit agencies in the region (or state) through the use of a single swipe or proximity card.

As noted previously, intergovernmental conflicts sometimes can occur. When disagreements between local communities arise, conflict resolution agreements have proven to be somewhat beneficial. These agreements help to resolve disputes in a timely fashion. By including due process procedures, a stalemate between dissenting government sectors can be avoided. Also, complaints from each community are able to be heard and discussed openly until a suitable compromise can be reached. It is anticipated that conflict resolution agreements can and will prevent unnecessary court involvement.

It would seem, then, from the literature that there are considerable differences between public and private missions, risk approaches, business objectives, and time frames. To obtain commitment from the private sector, profitable incentives need to be provided. For example, if the objective is to get the private sector to invest in research and development, one incentive would be to include the opportunity to exclusively utilize intellectual property rights over an extended period of time. To alleviate private sector apprehensions about laws requiring the surrender of these property rights, contractual agreements should encompass language that delineates the rights of each party to computer programs, patent-able inventions, and proprietary technical data that are developed during the partnership. Finally, incorporating various approaches utilized by the Europeans and the Japanese for public-private partnering may also prove to be beneficial.[16] Included in these approaches are the following:

- the formation of larger consortia of private sector participants;
- the use of sliding public-private funding in IVHS projects, with retention of intellectual property rights by private sector firms;
- the solicitation of ideas from the private sector for development of projects;
- infrastructure studies by the public sector that provide a platform for private sector activities; and
- the use of codes of practice to address liability concerns and stimulate product development.

> ***"In defining ITS Program staff requirements, the Department should explore opportunities for public/private partnerships and partnerships with local government agencies and other state agencies (e.g., Florida Highway Patrol) to provide operational support for the Department's ITS."***
>
> –excerpted from *Florida's Intelligent Transportation System Strategic Plan, Final Report,* Florida Department of Transportation, August 23, 1999

In Florida, FDOT's ITS Strategic Plan has taken into account the importance of partnering, especially public-private partnering. In the plan, one of the recommendations is that, as the State's MPOs plan for the integration of ITS into their respective transportation planning processes, they "evaluate potential ITS projects in light of alternative roles for the public sector, private sector, or public/private partnerships." In addition, the Business Plan for the State's ITS Program encourages the Department to develop a private sector outreach element within the ITS Program "to actively encourage private sector participation in ITS . . . ." According to the Business Plan, "participation by private sector partners is key to the full deployment of ITS in Florida." Finally, the Plan also encourages investigating the role of public-private partnerships in the funding of individual ITS projects and the State's ITS Program.

In the follow-up APTS inventor survey, Florida transit agencies were asked whether they currently are participating in any public-public and/or public-private partnering. According to the survey results, the primary partnering obstacles that have been experienced nationally appear to be occurring in Florida, as well. One of the most problematic issues is inexperience. Without experience, transit agencies have a difficult time devising and planning workable relationships. In fact, half of the responding Florida

[16] *Public and Private Sector Roles in Intelligent Vehicle-Highway Systems Deployment*, U.S. Department of Transportation, Federal Highway Administration, Washington D.C., August 1992.

systems reported no current or planned partnership agreements. According to the responses that were received, none of the responding transit agencies has established a public-private partnership, either. Most of those with partnering experience have been partners with other public entities. The APTS products and services that are currently being implemented and/or operated through public-public partnership arrangements are communications, scheduling, and traffic engineering. Two transit agencies mentioned their county partnership arrangements for radio communication systems. Another transit agency proposed a partnership with a neighboring county for inter-county transit service, although this service expansion will not start for several years. Yet another agency has an agreement with its city for radio communications and traffic engineering. Finally, one agency has a public-public partnership agreement for scheduling purposes.

Another prominent issue related to partnering is standardization. Currently, some agencies are hesitant to determine partnering options without first resolving compatibility constraints, such as "system configuration [between] areas." When transit agency staff were asked to discuss any opportunities that they believe exist for public-public and/or public-private partnerships for APTS, one-third could offer no suggestions or ideas for partnering options. Of those agencies that did provide potential public-public and public-private partnership ventures, several technology options were described. The responding agencies mentioned that APTS technology partnerships could enhance ride share programs, automatic vehicle location systems, traveler information systems, and advanced communication systems.

Public Involvement

According to the literature, one of the key elements common among successfully-implemented ITS projects is that, prior to and during the course of the deployment, the project team made public officials, stakeholders, and the general public aware of ITS and its benefits, especially as a solution for various transportation problems. Unfortunately, it is still the case that, despite best efforts to date to provide education and outreach, the awareness and understanding of ITS is still low among decision makers and the public. It is even low among many of the transportation officials and planners that should be prime advocates for ITS technology improvements, making it extremely difficult for them to suggest, promote, and/or evaluate such projects.

> ***"Many key decision makers in the transportation community – including elected officials, planning and operating managers, and technical staff – are generally unaware of the benefits of ITS. Moreover, the general public is not aware that ITS technologies are being used to solve real transportation and social problems. To create a favorable climate for ITS products***

and services, consumers and decision makers need to be aware and educated about the benefits of ITS."

–excerpted from *Saving Lives, Time and Money Using Intelligent Transportation Systems: Opportunities and Actions for Deployment*, ITS America, February 2000

Because of these low levels of awareness and understanding, it is apparent that the involvement of the public, as well as public officials and other decision makers, continues to be an especially important aspect of the development and deployment of ITS technologies. Most importantly, public officials help set policy and are also involved in funding decisions. Often, their decisions are based on the desires and demands of their constituents – the public. If the public understands the benefits of ITS and how it can help solve a variety of transportation issues, they will be more supportive of such solutions and more vocal in their demands for ITS implementation.

There are, however, two major issues concerning public involvement as it pertains to the implementation of ITS:

- Privacy
- Information Discrimination

The first issue, privacy, is not really unique to ITS, but it has become an increasingly problematic concern in the Information Age. In the 1993 study, *Privacy Implications Arising from Intelligent Vehicle-Highway Systems*, it was found that "75 percent of Americans expressed a distrust of government and concern over misuse of technology."[17] Electronic payment services, surveillance technologies, and other advanced technologies have increased significantly the amount of personal information that is being collected and utilized for transportation purposes. This increase in the availability and use of personal data has caused public sensitivity to privacy issues to grow, as well. Particularly, there are concerns that ITS-generated information will be utilized for secondary purposes, such as automated enforcement of traffic laws and criminal laws, as well as in civil actions. Other concerns include the commercial use and sale of personal information for profit and the security of databases containing individual-specific data.

To help deal with this issue, ITS America, through the Privacy Task Group of its Legal Issues Committee, developed a series of Fair Information and Privacy Principles. The intent of these

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[17] *Nontechnical Constraints and Barriers to the Implementation of Intelligent Transportation Systems, Update of the 1994 Report to Congress*, U.S. Department of Transportation, Federal Highway Administration, Joint Program Office for Intelligent Transportation Systems, Washington, D.C., 1997.

principles is to provide agencies and jurisdictions undertaking ITS projects with an advisory set of parameters for properly handling the information functions of the technologies being implemented. The principles, which received final approval on January 11, 2001, include the following:

- Individual Centered - ITS must recognize and respect the individual's interests in privacy and information use;
- Visible - ITS databases will be built in a manner "visible" to individuals (i.e., disclose to the public what data will be collected, how it will be collected, what its uses are, and how it will be distributed);
- Compliant - ITS will comply with applicable Federal and State laws governing privacy and information use;
- Secure - ITS will be secure;
- Law Enforcement - ITS has an appropriate role in enhancing travelers' safety and security interests, but absent consent, statutory authority, appropriate legal process, or emergency circumstances as defined by law, information identifying individuals will not be disclosed to law enforcement;
- Relevant - ITS will only collect personal information that is relevant for ITS purposes;
- Anonymity - ITS will allow, where practicable, individuals the ability to utilize ITS applications on an anonymous basis;
- Commercial or Other Secondary Use - ITS will ensure that information used for non-ITS applications is stripped of all personal identifiers;
- FOIA - ITS database arrangements should balance the individual's interest in privacy with the public's right to know based on Federal and State Freedom of Information Act (FOIA) obligations, which require disclosure of information from government-maintained databases; and
- Oversight - Agencies and jurisdictions deploying and operating ITS technologies should have an oversight mechanism to ensure that such deployment and operation complies with their Fair Information and Privacy Principles.

Following these principles can help agencies and jurisdictions implementing ITS technologies ensure that the misuse of data generated by ITS deployment is prevented. It is also important to note, however, that it is equally as imperative to prevent the public from fearing that the data will be misused. This especially will be key during the education process in order to help engender the public's support for ITS and prevent a potential backlash because of the privacy issue.

Related to the issue of privacy is the concern for information discrimination. Basically, this issue deals with the equity with which ITS-produced information is available to the public. For example, an advanced traveler information system can generate travel data for use by the public. The concern, however, is that the travel data may not be equitably available to everyone because of social, economic, or other demographic factors. There may even be a regional bias associated with the data's availability. If a private-sector agency involved in the deployment is tasked with the responsibility of distributing the travel data, it is likely that the data may have a fee associated with it, thereby discriminating against lower income travelers. The provision of location-specific data can also impact particular segments of the population and/or specific regions in a discriminatory fashion, as well.

> ***"The process of reaching out to the traveling public should start immediately, to inform them of the benefits that can be realized from ITS. All forms of media should be used to gain the public's support. When the public better understands the issues, they will be better prepared to provide feedback."***
>
> –excerpted from *ITS Strategic Deployment Plan, Final Report*, prepared by HNTB, TRW, and TEC, for the Ohio Department of Transportation - District 12, April 1996

The FDOT understands the importance of stakeholder support for ITS, particularly that of the public and decision makers. This understanding is reflected in the Florida Statewide ITS Strategic Plan, which includes the following guiding principles related to public awareness and involvement:

- Include education, training, and outreach for policy makers, the general public, and technical staff.
- Respond to special user needs – provide for the mobility and safety needs of commuters, tourists, goods movement, pedestrians, bicyclists, older road users, and mature drivers.
- Identify and support ITS advocates/champions – seek out and promote ITS champions in local government, public agencies, academia, and the private sector, including the general public.

To help reach out to the public and other stakeholders, FDOT's ITS Strategic Plan also prescribes the development and operation of ITS web pages for the State and each of the Districts in order to make ITS Program information more widely available. The Plan also calls for the development of a Statewide ITS Training Program to provide instruction on a variety of ITS elements, such as hardware operations and maintenance, telecommunications, software operations and maintenance, planning, and incident management.

Programs such as these should be welcomed by the Florida transit agencies, especially if they truly help increase the awareness and understanding of ITS and its benefits. According to the results of the follow-up APTS inventory survey, the vast majority of the responding agencies indicated that they are not satisfied with the level of public awareness of APTS. In fact, only one agency indicated satisfaction with the public's current awareness of APTS. The results were relatively similar for the survey question concerning the level of public official awareness of APTS. Only two agencies indicated satisfaction with the awareness of these particular individuals. The responding transit agencies provided the following methods for increasing the awareness of APTS:

- education;
- presentations;
- television/radio coverage;
- web sites with FAQ (frequently asked questions) pages;
- demonstration projects; and
- newspaper articles.

It is interesting to note that, on the survey, in discussing the factors that have impeded the deployment of APTS, the lack of ITS knowledge on the part of the implementing agencies is one factor that was mentioned. It should come as no surprise, then, that the public still is relatively unaware and uninformed, as well. As planners, technical staff, and transportation officials become more knowledgeable about ITS/APTS and its capabilities, then it should become easier to pass this information on to decision makers and the public in order to educate them and engender their support for deployment activities. The results of another of the survey questions seems to bear this out, as well, as the responding transit agencies suggested that education and awareness were two of the activities that are necessary to ensure and maintain the success of APTS.

Regional Integration

ITS can be defined by its many integral parts, such as traffic, emergency, and transit management, among others. Obviously, efficiency in all areas is required to achieve a truly integrated and effective transportation system. Most of the literature related to ITS applications focuses more on traffic management, while not adequately addressing the role that transit plays in the overall management of transportation. Fortunately, the role that APTS plays in regional transportation management centers (TMCs) is being defined in areas across the country and the momentum to increase the role of transit as part of the solution for more efficient transportation systems is growing.

"In some cases, transit was an afterthought when metropolitan areas began to approach traffic management and control from a regional perspective, and realized that transit plays a significant role in regional transportation."

–excerpted from *Review of and Preliminary Guidelines Integrating transit into Transportation Management Centers*, prepared by EG&G Dynatrend for Volpe National Transportation Systems Center, Federal Transit Administration, July 1994

TMCs employ advanced technologies to provide transportation information and to manage and control transportation networks. Ideally, TMCs involve multiple agencies throughout a region that have an interest in and impact on transportation. For any one of these agencies to narrowly focus on transportation management from its own perspective without giving consideration to the practices and abilities of the others to influence transportation efficiency would be a mistake. Historically, these centers were mainly traffic management in nature and they did not include transit; however, when the APTS program was established, it became even more clear that the innovations of advanced technology for public transportation would have profound effects on transportation management, overall. In an effort to assist those areas that are considering the integration of transit and APTS applications into TMCs, FTA developed guidelines for establishing the organizational and institutional mechanisms that can assist in effecting cooperation and coordination among participating agencies.

According to the *Review of and Preliminary Guidelines Integrating Transit into Transportation Management Centers*, there are a number of general guidelines, bulleted below, for the integration of APTS and transit operations into a TMC.[18]

- Co-location is not necessary, however, when transit dispatch and traffic operations are physically bound, the exchange of information is facilitated.
- Organizational and institutional cooperation of the transit and traffic management entities is more important to the success of the TMC rather than the technologies that are used.
- Roles and responsibilities of the participating agencies need not change drastically to be a part of the TMC.
- Each agency or organization involved in the TMC must contribute resources and expertise for the TMC to be most effective.
- Successful integration may require that non-transit agencies are educated on the importance of transit to the advancement of regional transportation efficiency.

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[18] Schweiger, Carol L., *Review of and Preliminary Guidelines for Integrating Transit Into Transportation Management Centers,* Volpe National Transportation Systems Center, Federal Transit Administration, July 1994.

- Technologies applied in the collection of transit and traffic data by the TMC will improve the effectiveness of managing regional transportation, but will not be a substitute for transportation management.

"A [TMC] employs advanced technologies to provide multimodal transportation information and/or to manage and control transportation networks. . . The increase in coordination and information dissemination allows both for more intelligent decisions to be made on the part of trip-makers and more appropriate and timely response to incidents by transportation and emergency personnel, when they arise."

– excerpted from *New Technology in Mass Transit,* prepared by the Research and Special Programs Administration, Volpe National Transportation Systems Center, http://www.fta.dot.gov/transcity/its.its.html

In developing the guidelines for integrating transit into TMCs, the authors surveyed several existing TMCs to identify common factors to their success. One of the conclusions made was that the co-location of transit dispatch and operations with traffic management operations could facilitate more efficient communication; however, it was not necessarily required to achieve the prudent exchange of information since advanced communication links can allow all entities to share and benefit from real-time data.

The participants in the study also agreed that, while the employed technologies play an important part in the successful integration of transit and traffic operations in a TMC, its success depends much more on the ability to minimize organizational and institutional barriers. A suggestion from the guidelines manual was that newly formed or redeveloping TMCs should focus on goals that will clearly demonstrate the value of each entity to the TMC, further clarifying that, as a consortium, the TMC is much stronger and effective than any of the individual agencies.

Another barrier to successful integration of transit dispatch operations and traffic operations in a TMC is not having a clear understanding of the roles and responsibilities in coordinating efforts. As each organization enters the TMC as an able partner, their basic roles and responsibilities should remain unchanged. For instance, a transit agency is still responsible for organizing and providing public transportation and traffic management is still responsible for measuring freeway congestion. However, to optimize the impact that the entities could have on transportation management overall, measures can be taken to allow each entity to use its resources to assist the other. In some areas, the buses that are tracked in real-time by automated vehicle location technology are simultaneously used as probes by the TMC to assist the traffic managers in determining traffic congestion levels. The exchange of data further demonstrates the value of each entity's purpose and resources.

Historically, the role of transit in effective transportation management has been severely discounted. To achieve true integration of ITS technology in transit and traffic management, non-transit entities may have to be educated about the roles, resources, and benefits of transit to the overall goal of optimizing transportation efficiency. Consider the case of the Greater Houston Traffic Management Center. This particular TMC is managed by an Executive Director who reports to an Executive Committee that consists of municipal, traffic, and transit representatives. This organizational scheme ensures that transit's importance is recognized and that its goals are considered in the activities of the TMC. Additionally, it is apparent from this scheme that, sometime during the process of developing the Greater Houston TMC, the participating organizations were made aware of, understood, and accepted the value of transit to the overall transportation management effort.

> ***"Each district should develop an ITS infrastructure and initiate development or enhancement of a transportation management center focusing on the Interstate highways. Consideration should be given to evolving the center to have multimodal management capabilities and to be operated in urban areas at Level of Service (LOS) 3 within five years."***
>
> –excerpted from *Florida's Intelligent Transportation System Strategic Plan, Final Report,* Florida Department of Transportation, August 23, 1999

The Florida ITS Strategic Plan states that the "Department should pro-actively support the development, coordination, and deployment of public transportation ITS technology" by involving transit agencies in the planning, development, and operation of TMCs. The Strategic Plan also suggests that the MPO facilitate institutional and inter-jurisdictional cooperation and coordination in the planning, deployment, and operation and management of ITS, and that policies and strategies are developed to provide technical and financial support for those transit agencies that wish to integrate their systems into regional architecture. Interestingly, the State's ITS Business Plan, which delineates how the Strategic Plan will be implemented, proposes that each FDOT District will establish and staff at least one TMC within five years.

The follow-up APTS inventory survey results suggest that most of the responding transit agencies agree that transit should be combined with regional transportation services and traffic operations to form regional TMCs. However, there was some level of skepticism indicated that such integration would occur under the current state of bureaucracy. When asked what interlocal agreements or memorandum letters of understanding would be required to successfully integrate the advanced technologies of transit and traffic operations, half of the respondents agreed that contracts between FDOT, city and county authorities, transit agencies, and MPOs would be required. The other half of the respondents did not offer any opinions on the types of agreements that might facilitate such cooperation. Further, some of the stakeholders interviewed agreed that APTS systems should be interoperable and that regional transportation services and traffic operations combined in a regional TMC is important.

Rural Applications

While the benefits of ITS are most often touted for urban areas, it is now recognized that these benefits can easily be translated to rural areas. In fact, the U.S. DOT developed the Advanced Rural Transportation Systems (ARTS) program to "meet the needs of travelers in and through rural areas, as well as the agencies responsible for the operation and maintenance of the rural transportation system." Rural America accounts for 80 percent of the total U.S. road mileage and 40 percent of the vehicle miles traveled.[19] This dispersed transportation environment introduces important issues for transit providers. ITS can significantly improve the provision of transit in terms of efficiency and accessibility to rural residents, who are, by a large percentage, elderly and/or without adequate transportation. Nearly 40 percent of people in rural America have no access to public transportation and another 28 percent have inadequate service.[20] Therefore, technology designed to reduce the level of isolation for this segment of the population is important. Through a variety of technologies, such as vehicle-locating techniques, communications systems, and automated fare collection systems, public transportation in rural areas can be advanced to improve transit accessibility, dispatch and routing efficiency, and ride sharing and matching capabilities.

Of the ITS applications that are currently available, dispatch and routing technologies most often are engaged by rural transit operations. The most common of these technologies are computer-aided dispatch (CAD) and automatic vehicle location (AVL). CAD technology is also referred to as dynamic scheduling software and it automates the process of assigning ride requests to vehicles. AVL allows dispatchers to track vehicles in real-time. The obvious benefit of these technologies is the potential to improve the cost-efficiency of trip making for paratransit/demand-responsive services through better schedule adherence, automated rescheduling, and the development of optimal dispatch strategies. Other operator benefits include a greater accountability of fleet activity, improved data for service planning, better interagency coordination, greater adaptability to last minute trips and cancellations, and reduced vehicle-miles-traveled. User benefits include reduced advance reservation times, reduced waiting times, and faster travel times.

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[19] *Techbrief: Rural ITS,* U.S. Department of Transportation, Federal Highway Administration, Turner-Fairbank Highway Research Center, April 1999.

[20] *Intelligent Transportation Systems Benefits: 1999 Update*, U.S. Department of Transportation, Federal Highway Administration, ITS Joint Program Office, May 1999.

"Fleet management systems with vehicle location capability are producing benefits in productivity, security, and travel time. In addition, several operators have reported incidents where AVL information assisted in resolving disputes with employees and patrons. A 1996 study found 22 U.S. transit systems operating more than 7,000 vehicles under AVL supervision and another 47 in various stages of procurement. The new procurements represent a tripling of the number of deployed systems . . . ."

–excerpted from *Intelligent Transportation Systems Benefits: 1999 Update*, U.S. Department of Transportation, Federal Highway Administration, ITS Joint Program Office, May 28, 1999

Rural areas across the country have measured the benefits of their ITS programs. The transit system in Sweetwater County, Wyoming, after installing CAD and AVL, increased ridership by nearly 80 percent without increasing the size of its dispatch staff.[21] In Bakersfield, California, the vehicle trip length and travel time were reduced by 10 percent and in Madison County, Illinois, the cut-off time for a next-day trip request was extended by two and one-half hours.[22]

Through operations software systems, passengers are able to make reservations, check on ride status, and obtain billing information using touch-tone telephones, personal computers, and other methods. For many providers in rural areas, these benefits have translated into a dramatic increase in ridership while reducing miles traveled. The improved services mean that many of the elderly or physically-challenged persons that utilize paratransit and demand-responsive services are able to make necessary appointments and enjoy a more acceptable level of mobility.

In metropolitan areas, considerable attention has been given to electronic fare payment technologies such as magnetic strip cards, smart cards, and interagency billing capabilities. The magnetic strip, smart, and proximity cards are automated fare payment systems that use electronic communication, data processing, and data storage technologies to automate the collection of fares. Many transit agencies, larger ones in particular, have experienced results of faster boarding, fewer instances of fare evasion, and a reduction in money handling costs with the use of automated fare payment systems. Whether automated fare payment will provide similar benefits in rural areas, or whether they are necessary, is questionable. APTS studies have suggested that the equipment to read magnetic strip or smart cards

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[21] Casey, Robert F., *The Benefits of ITS Technologies for Rural Transit,* Volpe National Transportation Systems Center, presented at the National Rural Intelligent Transportation Systems Conference, Spokane, WA, November 1996.

[22] *Personalized Public Transit*, ITS Decision report, http://www.path.berkeley.edu/~leap/PTO/Personal_Pub_Transit/index.html, last update: November 7, 2000.

could be more expensive than conventional fareboxes, particularly in areas using demand-responsive and paratransit services. In addition, as the fares for a great proportion of transit users in rural areas are paid through third-party billing, the reduction in money handling costs could be minimal.

However, another electronic fare payment application, usually designed for multi-carrier or interagency billing, can be used to afford rural transit agencies the ability to automate their interagency billing and accounting processes when third party agencies are involved. It also can be used to coordinate processes between multiple transit operators and allow the patrons to pay fares through use of one fare payment card. This technology simplifies coordination between multiple transit and social agencies, which many of the elderly riders depend upon in rural areas. Fare payment cards also have the ability to assist the rural transit agencies in maintaining user profiles on their patrons so that they are better able to adapt service to changing demographics.

A study team, sponsored by the U.S. DOT, found that, of 10 rural or small urban transit systems that had deployed or planned to deploy APTS technology, only 2 *planned* to eventually deploy electronic fare systems.[23] Through the same U.S. DOT study, many of the constraints to deploying ITS in rural areas were identified. *Rural Public Transportation Technologies: User Needs and Applications* found that few rural transit systems had implemented or were familiar with ITS technologies. The study also stated that smaller transit systems faced more difficulty championing the benefits and justifying the costs of ITS as their budgets were more constrained or limited. In addition, the same constraints to ITS that effect urban areas also apply to rural areas (e.g., limited funding, poor integration, ineffective procurement, unsuccessful communication of benefits, etc.).

> ***"The overall economic vitality of Florida also requires that safe and efficient movement of people and goods be maintained within and through the rural and inter-urban areas of Florida. However, unlike most urban areas, rural mobility and safety needs are relatively isolated or dispersed. ITS applications in rural and inter-urban areas can therefore be viewed as a tool for providing contiguous traffic monitoring and traveler information only if specific problem areas can be identified, and cost-sharing and real-time information-sharing can be maximized."***
>
> –excerpted from *Florida's Intelligent Transportation System Strategic Plan, Rural/Inter-Urban ITS Applications Issue Paper,* Florida Department of Transportation, March 8, 1999

[23] *Techbrief: Rural Public Transportation Technologies: User Needs and Applications*, U.S. Department of Transportation, Federal Highway Administration, Turner-Fairbank Highway Research Center, September 1998.

A goal in Florida, according to the *Rural and Inter-Urban ITS Applications Issues Paper* of FDOT's ITS Strategic Plan, is to advance ITS in rural communities from operational testing in select areas to full ITS deployment across the state. The objectives are to improve the efficiency, accountability, and interagency coordination of services, particularly for the transportation disadvantaged. The ITS Strategic Plan also specifically addresses the need to encourage federally-designated rural enterprise communities to include ITS in their development goals.

FDOT has identified the Florida Commission for the Transportation Disadvantaged and paratransit Community Transportation Coordinators as valuable resources for increasing the awareness and utilization of ITS in rural areas. The constraints to implementing ITS in rural areas mirrors those of the metropolitan areas. The unfamiliarity of rural transit operators with the benefits of and opportunities for ITS deployment in rural Florida can slow the advancement of rural ITS. However, as more rural areas encounter successful experiences with ITS applications, such as the coordinated AVL project in Putnam, St. Johns, and Flagler Counties, and as the costs and benefits of these experiences are more consistently documented and shared, more transit operators in rural areas will be encouraged to implement ITS technologies, as well.

In the initial APTS inventory survey, most of the 19 respondents indicated that they were planning, testing, or operating an automated paratransit scheduling system. This is not surprising since, according to much of the ITS literature, automated scheduling appears to be one of the most popular introductory APTS applications among paratransit providers. None of the systems that primarily service rural areas acknowledged having automated fare payment technology, but three operate or are planning a multi-carrier reservations and billing system. The lack of participation in automated fare payment technology may be reflective of the perceived lack of necessity by the transit operators since there usually exists a greater presence of third party billing incidences over actual fare collection.

From the follow-up APTS inventory survey responses, it is apparent that the responding agencies believe automated vehicle location, automated trip scheduling, and advanced communications will be the most beneficial APTS technologies for application in rural areas – a finding that corresponds with the initial inventory results that identified these particular applications as being popular among the responding agencies. This result is evident in the agencies responses to the survey question that asked for the potential benefits that could result from applying APTS to rural areas. The benefits that were indicated are as follows:

- vehicle tracking;
- scheduling/dispatching of paratransit trips;

- communications;
- traveler information; and
- improved efficiencies.

One system even indicated that "lives will be made easier" and that "all possible benefits" could accrue from the use of APTS technologies.

Benefits Analysis & Performance Monitoring

One of the most notable hindrances to greater APTS deployment is the lack of qualitative and quantitative measurements of benefits to the transit industry when APTS technologies are applied. Performance measurement and benefits analysis are critical because they acknowledge efficiencies and aid in justifying costs. When new technology is introduced, no matter what the industry, the key to acceptance is demonstrating that its use will yield better service at lower costs. Decision makers need to have objective evaluations of ITS operations that clearly delineate the benefits so that, during this time of limited funding, positive gains for the industry, transit agencies, and transit users are achieved. ITS deployment is *relatively* new and an extensive history of data on either the cost or benefit does not exist. Presumably, this lack of data has prompted a demand for transit agencies to more consistently share performance evaluations and benefit data with one another.

> ***"Funding for Intelligent Transportation System (ITS) projects is becoming scarcer, and this trend will continue unless ITS proponents are able to demonstrate gain from on-going ITS projects. The problem is not insurmountable. There are demonstrable gains from current ITS projects, and many of these gains are of significant interest to public policy makers and potential ITS sponsors. However, as a community, we have failed to effectively communicate ITS achievements to the public."***
>
> – excerpted from *ITS Evaluation: A New Framework*, an abstract by Richard Harris, Richard Staats, and Ronald Bailey, Logistics Management Institute, viewed online at http://www.itsonline.com/lmi/isatax.htm

Performance monitoring is first introduced during the operational testing phase of ITS deployment and should continue throughout to ensure that the system is responding as desired. Performance monitoring provides the agency with an idea of how the system is working defined by preset measures of effectiveness. The benefits of performance monitoring and evaluation transcend solely justifying costs, however, as it identifies areas in which the system needs improvement.

Benefit analysis, on the other hand, is done by objectively comparing the results of performance monitoring with the direct and indirect costs of implementing the system. This is most often used by state and local agencies when justifying the need for ITS technology with public and private funding providers. While the U.S. DOT, through the ITS Joint Program Office (JPO), has gathered information on the impacts of ITS projects, it acknowledges that there exists an unacceptable lack of benefits data available for transit agencies to use in this justification process. The lack of data sources is partly a result of the failure of those state and local agencies that *have* implemented ITS to adequately monitor the performance of the applications and to promptly publish the resulting benefits demonstrated through any performance monitoring that *has* been done.

The development of a performance monitoring plan is crucial when deciding to implement ITS technology. To successfully identify the true benefits and even the shortcomings of a system, the evaluating agency must identify the criteria to be measured and the units of measurement. The *Technical Edition of the ITS Deployment Guidance for Transit Systems* identifies suggested "measures of effectiveness," or MOEs, and recommends that they be used as indicators in the evaluation of a system's performance.[24] Ideally, the MOEs should represent the concerns of the stakeholders, who might include transit operators, riders, and private partners. They might measure safety, cost, capacity, satisfaction, and delays. Examples of measures identified in the *ITS Deployment Guidance for Transit Systems* include:

- number of transit riders/year;
- transit vehicle occupancy;
- travel times (minutes);
- queue lengths;
- total annual transit miles; and
- transit revenue.

"Evaluations are critical to understanding the value, effectiveness, and impacts of the ITS program activities. Significant policy issues can only be addressed if the benefits, costs, and risks can be identified for each project. Indeed the lack of or failure to use aids that help guide the public use of scarce resources will threaten the quality of decisions."

–excerpted from *Cost/Benefit Analysis*, ITS Decision resources, http://www.path.berkeley.edu/~leap/itsdecision_resources/cost_benefit.html, last update: July 15, 2000

[24] *ITS Deployment Guidance for Transit Systems Technical Edition*, U.S. Department of Transportation, April 1997.

While performance monitoring can provide immeasurable benefit to the implementing agency, benefit analysis is also of great use to other agencies that are planning to use a similar technology. The value of the ITS application in relation to costs is an invaluable tool for justification. By identifying the shortcomings of an ITS application, an implementing agency can make adjustments and can share those shortcomings with other agencies that are undertaking similar endeavors.

In connection with the July 12, 2000, ITS Benefits Data Needs Workshop, Mitretek Systems prepared a report entitled, *ITS Benefits: Data Needs Update 2000.* The purpose of the document is "to summarize and highlight where gaps or limited knowledge exists concerning the benefits of ITS services" so that additional evaluation of those services can be encouraged and so that the JPO might best determine "where limited evaluation resources may provide the most advantage."[25] The information presented in the report resulted from the work of the data needs task force that participated in the workshop and were tasked with developing, reviewing, and rating a listing of data needs. A survey was used to accomplish the rating of the data needs. One general finding from the survey included overall higher priority rankings for data issues within metropolitan application areas versus those within rural application areas. Among the metropolitan ITS application issues, incident management on arterial systems, data archiving, and operations and maintenance received the highest priority scores for requiring additional benefits analysis. Among the rural-based issues, high priority for more benefits analysis was given to emergency services, operation and maintenance, and crash prevention and security. Finally, in specific relation to transit, the task force indicated considerable interest in acquiring more benefits data for the impact of ITS on transit management systems (e.g., AVL and computer-aided dispatch), maintenance, transit information systems, and security.

The Florida ITS Strategic Plan does not directly acknowledge a goal of improved performance monitoring or benefits analysis. However, it states that an essential element of management and operation of ITS projects is the "monitoring of transportation facilities performance on a real-time basis . . . to provide information for improved operations." The *Economic Impacts Issue Paper* for the plan addressed transportation system efficiency gains (found on the national level) attributable to the ITS deployment and then extrapolated those gains to predict impacts of ITS on Florida. Unfortunately, neither the plan nor the issue paper addressed the underlying shortcoming of not having adequate benefits analysis and evaluation *at* the state and local level. This deficiency was mentioned by several of the transit agencies that responded to the follow-up APTS inventory survey.

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[25] Proper, Allen T. and Rob Maccubin, *ITS Benefits: Data Needs Update 2000,* prepared in connection with the 12 July ITS Benefits Data Needs Workshop, Mitretek Systems, August 29, 2000.

None of the respondents to the survey acknowledged that a benefits analysis was done prior to or after their respective deployments. However, many agencies recognized that "comparing notes" and "celebrating your successes" were activities necessary to ensuring or maintaining the success of ITS deployments. The transit agencies seem to be receptive to sharing their ITS experiences with other agencies in Florida; however, without consistent guidelines for performance monitoring and benefit analysis, the successes of these deployments may not be recognized as an objective representation of the technology's effectiveness and efficiency.

SUMMARY OF CHAPTER TWO

This second chapter of the Inventory and Analysis of Advanced Public Transportation Systems in Florida report has provided a variety of information on 10 specific characteristics related to the development and/or deployment of APTS. It also has documented the experiences that a number of Florida transit systems have had with these particular issues, based on the results of the follow-up APTS inventory survey and the stakeholder meetings.

> ***"For ITS to be successful, the many partners in the transportation system – including highway and transit officials in Federal, State, and local governments – must coordinate their efforts and work as a team. Public-private partnerships and participation by urban and rural organizations are also necessary, as is the support of the public."***
>
> –excerpted from *Safer, More Efficient Travel with Intelligent Transportation Systems*, an ITS white paper produced by the Federal Highway Administration and the Federal Transit Administration for use by members of the National Associations Working Group for ITS, Pub. No. FHWA-SA-97-087

From the literature review, it is evident that the decision to utilize a particular ITS technology is only the first step of an extensive, and often challenging, process that runs from development, to deployment, and finally to the operation and maintenance of the chosen technology. For example, if a transit system wants to incorporate APCs on a portion of its fleet for data collection purposes, the decision making does not end with the selection of a particular APC technology and vendor. A host of other considerations must be taken into account, including:

- Will this component be able to be integrated with others should the need or desire arise for the implementation of other APTS technologies (e.g., AVL)?
- How will the APCs be procured?

- How will all aspects of the technology be funded, including installation, maintenance, and data compilation and analysis?
- Will it be beneficial to partner with other agencies, public or private, and how will those relationships be established and structured?
- What level of involvement, or "buy-in," will be needed from board members, local officials, and/or the public?
- What impact will the increased influx of data have on planning staff? Will it be possible to utilize the data in a timely and beneficial manner to positively support agency operations?
- What impact will upkeep and repair of the APC equipment have on maintenance staff?

Therefore, a lot of planning and forethought must go into the development and implementation of any ITS technology. Agencies considering the deployment of a technology will want to understand the National ITS Architecture (or any state or local architecture that has been established) and use it as a guideline during the process. If partnering is desired, it also would be prudent for an agency to understand the issues involved with various institutional arrangements (i.e., interagency, jurisdictional, public-private, and/or technical capability issues). Identifying and enlisting a wide range of stakeholders in the project also will be advantageous to its success, as will ensuring that the implementation plan clearly establishes the stakeholders' roles and responsibilities, and allows for and encourages interagency coordination.

Like most other transit projects, funding will be an important issue in the process to implement ITS. Capital funding will be needed for the acquisition and installation of equipment and supporting software applications. However, it is the funding that will be needed to upkeep and operate the ITS technology on a day-to-day basis for which most agencies will struggle to identify a source. Operation and maintenance of the equipment will depend on the appropriate allocation of staff for those tasks. Staff also will be needed to deal with the timely and regular retrieval, analysis, and use of the resulting information from the operation of the technology. It is only through the appropriate levels of funding and staff resources that the full benefit of any ITS technology application will be reached.

Similarly, procurement of an ITS technology can also be a complicated step in the process because ITS proposals are not well served by traditional procurement practices. The complexity of most technologies and the need to adapt to constantly evolving applications require that procurement procedures be much more flexible in nature. These more adaptive procedures will help agencies be able to better account for desired goals, such as interoperability and the ability to be integrated with other technologies in the future, when procuring an ITS technology.

A key element of many of the ITS projects that have been successfully implemented around the country is the awareness and involvement of public officials and the general public. Unfortunately, understanding of ITS and its benefits is still quite low among decision makers and the public. Since these constituencies play an important role in setting policy and establishing funding priorities, it is in the best interest of agencies implementing ITS technologies to ensure that they are made aware of ITS solutions to transportation problems and other issues. If politicians and the public understand the benefits of ITS and how it can help solve existing problems, they will be more supportive of efforts to implement these technologies.

As more people understand ITS and how it can help solve real-world issues, it will be easier to promote the more widespread implementation of ITS technologies. Eventually, it will be possible to plan for deployment that will integrate services and systems across a region, thereby ensuring seamless coverage and interoperability. In terms of mobility, transportation management centers can be established that will utilize advanced ITS technologies to provide transportation information, as well as manage and control transportation networks, on a regional basis. Ultimately, transportation will be able to be integrated at the statewide level for the seamless connection with transportation systems in neighboring states and across the country.

This regional outlook for the implementation of ITS technologies incorporates rural areas and the demand-response services that are utilized in those areas, as well. ITS technologies such as AVL and CAD have been utilized successfully for rural applications, and have benefitted rural transit providers by helping to improve the efficiency of demand-response service scheduling and operation. It is also anticipated that technology implementation also will help improve interagency coordination of services. In fact, this is one of the specific goals of the Rural Florida ITS demonstration project, which was begun in 1998.

Finally, one of the greatest hurdles that agencies will need to overcome when implementing ITS technologies is the justification of the costs in comparison to other potential improvements. This is why benefits analysis and performance measurement are critical to this process. As noted previously, prior to deployment it will be important to understand the potential benefits of the technology under consideration and demonstrate those benefits to the decision makers and all stakeholders. Performance monitoring becomes crucial during the operational testing phase of the deployment to make sure that the system is working as planned. After that, continued monitoring of performance is necessary to ensure that all facets of the system continue to operate properly. Benefits analysis then objectively compares the results of the performance monitoring with the direct and indirect costs of system implementation and, hopefully, justifies need for that technology. In addition, it will be important for agencies to share the results of their analyses with others contemplating implementation. Unfortunately, the lack of qualitative and quantitative measurements of ITS technology benefits has been found to be one of the most notable hindrances to greater ITS deployment to date, especially for transit purposes.

CHAPTER THREE
APTS BENEFITS ANALYSIS & PERFORMANCE MONITORING

INTRODUCTION

As noted in the previous chapter, it is extremely important for a transit agency considering the implementation of, or actually deploying, a particular APTS technology to assess its potential benefits prior to implementation and monitor its performance after deployment. These analyses are beneficial because they can help highlight efficiencies and can aid in the justification of costs. Another major benefit is that these analyses can also provide an agency with important support information as it shares its deployment/operation experiences with other agencies and the transit industry, as a whole. This sharing of qualitative and quantitative measurements of APTS benefits with the industry is considered to be an important key to increased APTS deployment throughout the U.S.

In this third chapter, a spreadsheet-based analysis tool is utilized to assess the benefit(s) that a selected group of transit systems have accrued through the implementation of an APTS technology. Four Florida transit agencies and one agency from outside the state have been selected by CUTR, and approved by FDOT, for inclusion in this particular analysis. To conduct the analysis, the tool utilizes pre- and post-deployment data provided by these agencies for specific performance variables. In addition, a discussion of post-deployment performance monitoring also is included herein, with some general recommendations for performance measures that should be considered by transit agencies.

APTS BENEFITS ANALYSIS

To conduct an APTS benefits analysis for the purpose of exemplifying this type of review process for transit agencies throughout Florida, it was first necessary to determine the tool(s) that would be used and the transit system(s) that would be analyzed as case studies. During the scoping stage of the project, two different computer-based analysis tools were identified that would be considered for use in this analysis, SCRITS (Screening Analysis for ITS) and IDAS (ITS Deployment Analysis System). In addition, CUTR identified several in-state and out-of-state transit agencies that would be promising candidates for inclusion in the study.

Ultimately, with the assistance of FDOT, it was decided that the SCRITS tool would be utilized in the case studies and five systems were selected for analysis: Pinellas Suncoast Transit Authority, Hillsborough Area Regional Transit Authority, LYNX Transit, and Sarasota County Area Transit in

Florida, and Ann Arbor Transportation Authority in Michigan. The following sections briefly describe the two analysis tools that were considered and the reasons for the decision to utilize SCRITS instead of IDAS, as well as the participating transit agencies.

Assessment Tools

As discussed previously, two assessment tools were suggested in the original project scope for review to determine which could best be utilized to conduct APTS-related benefits analyses for a selection of transit agencies. Both tools, SCRITS and IDAS, are computer-based and were developed to provide sketch-level planning analysis capabilities for ITS applications, including the assessment of potential benefits. These tools are described more in-depth in the next two sections, followed by a brief discussion of the rationale for ultimately selecting SCRITS to complete the analyses documented herein.

IDAS

According to information from a promotional brochure, the IDAS product website (http://www.camsys.com/tod/idas/index.html), and the McTrans website (http://mctrans.ce.ufl.edu/featured/idas/), IDAS, or the **I**TS **D**eployment **A**nalysis **S**ystem, is a sketch-planning analysis tool that can be used to estimate impacts, benefits, and costs associated with the implementation of ITS technologies. Developed by a team led by Cambridge Systematics, Inc., for the Federal Highway Administration (FHWA), this software is intended to assist public agencies and consultants in integrating ITS into the transportation planning process. To this end, IDAS relies on the modal split and traffic assignment outputs from existing travel demand forecasting models (e.g., FSUTMS) to estimate changes in the modal, route, and temporal decisions of travelers that occur due to ITS deployment. Utilizing this software, it is possible to predict relative costs and benefits for more than 60 types of ITS investments, including automated scheduling and automatic vehicle location for both fixed-route transit and paratransit services and five other transit-specific components.

IDAS is also capable of evaluating and quantifying the impacts of ITS infrastructure improvements throughout a transportation network. These impacts can include user mobility, travel time and speed, travel time reliability, fuel costs, operating costs, accident costs, emissions, and noise, among others. It also is possible to view the performance of particular ITS options by mode, facility type, and/or district. Analysis results are output to a benefit/cost summary report and a series of performance summary reports. Examples of these reports are illustrated in Figures 1 and 2. In addition, IDAS can be utilized to analyze how an ITS project can affect agency efficiency and/or system reliability. As a sketch-planning analysis system, it is important to note, however, that the program is intended to be used as a tool for alternatives analysis and not for the optimization of ITS operations. According to documentation, some of the other capabilities of the software include:

- comparison and screening of ITS alternatives;
- estimation of life-cycle costs;
- inventory of ITS equipment;
- identification of cost-sharing opportunities;
- sensitivity and risk analysis;
- ITS improvement scheduling; and
- documentation for transition into design and implementation.

IDAS is designed to operate in the Windows NT 4.0 environment; however, it can also run in a Windows 95 environment (despite issues with network-viewing capabilities that may result from incompatible hardware configurations). A fully functional Windows 95/98 version was due on the market in July 2000, although the current availability of this version could not be verified. IDAS's graphical interface and its use of complex algorithms in its traffic assignment process necessitate the utilization of at least a 300 megahertz Pentium II processor to run the software. The system requirements also recommend the availability of at least 128 megabytes of RAM and at least 2 gigabytes of free disk space to properly run the IDAS program.

Figure 3-1
Benefit/Cost Summary Report - Example Output

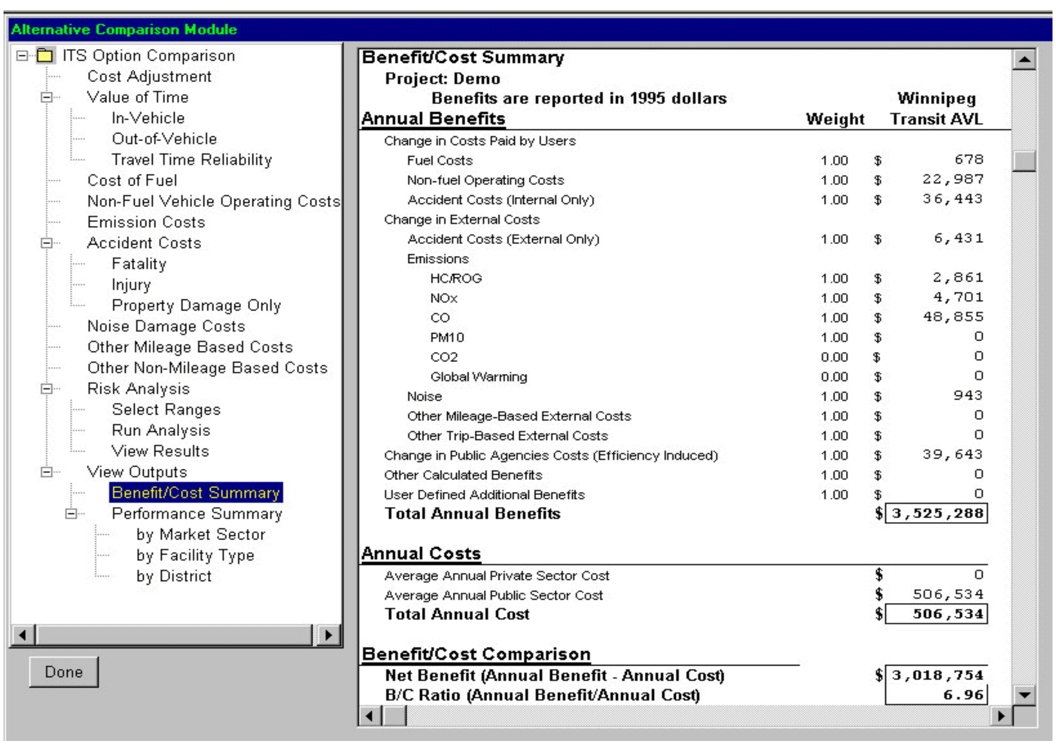
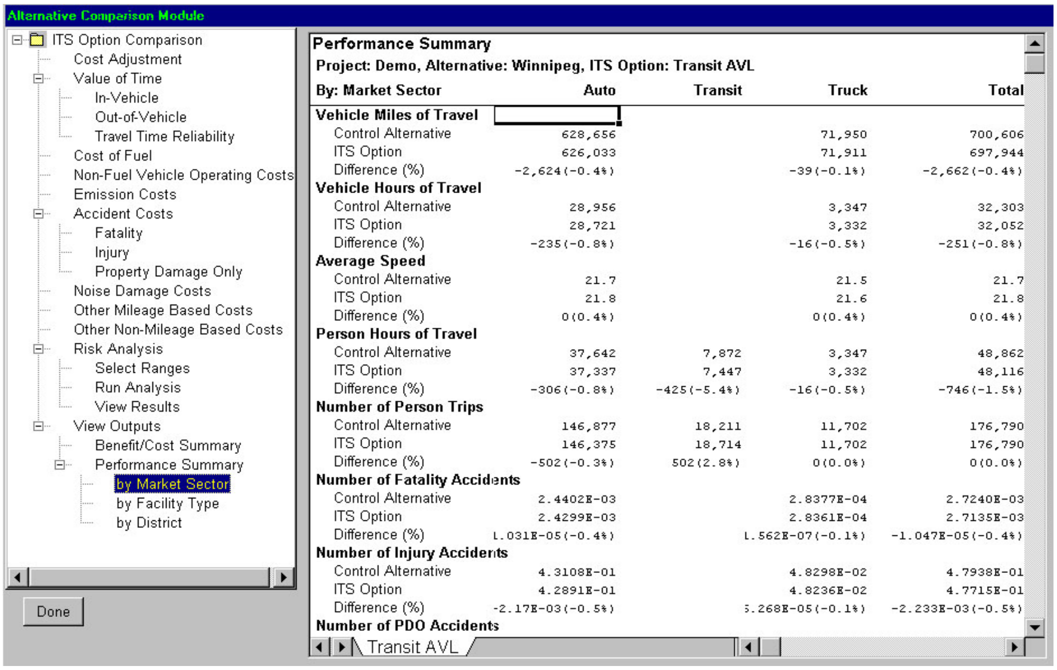


Figure 3-2
Performance Summary Report - Example Output



Performance Summary
Project: Demo, Alternative: Winnipeg, ITS Option: Transit AVL

By: Market Sector	Auto	Transit	Truck	Total
Vehicle Miles of Travel				
Control Alternative	628,656		71,950	700,606
ITS Option	626,033		71,911	697,944
Difference (%)	-2,624(-0.4%)		-39(-0.1%)	-2,662(-0.4%)
Vehicle Hours of Travel				
Control Alternative	28,956		3,347	32,303
ITS Option	28,721		3,332	32,052
Difference (%)	-235(-0.8%)		-16(-0.5%)	-251(-0.8%)
Average Speed				
Control Alternative	21.7		21.5	21.7
ITS Option	21.8		21.6	21.8
Difference (%)	0(0.4%)		0(0.4%)	0(0.4%)
Person Hours of Travel				
Control Alternative	37,642	7,872	3,347	48,862
ITS Option	37,337	7,447	3,332	48,116
Difference (%)	-306(-0.8%)	-425(-5.4%)	-16(-0.5%)	-746(-1.5%)
Number of Person Trips				
Control Alternative	146,877	18,211	11,702	176,790
ITS Option	146,375	18,714	11,702	176,790
Difference (%)	-502(-0.3%)	502(2.8%)	0(0.0%)	0(0.0%)
Number of Fatality Accidents				
Control Alternative	2.4402E-03		2.8377E-04	2.7240E-03
ITS Option	2.4299E-03		2.8361E-04	2.7135E-03
Difference (%)	1.031E-05(-0.4%)		1.562E-07(-0.1%)	-1.047E-05(-0.4%)
Number of Injury Accidents				
Control Alternative	4.3108E-01		4.8298E-02	4.7938E-01
ITS Option	4.2891E-01		4.8236E-02	4.7715E-01
Difference (%)	-2.17E-03(-0.5%)		5.268E-05(-0.1%)	-2.233E-03(-0.5%)
Number of PDO Accidents				

SCRITS

Screening Analysis for **ITS** (SCRITS) is a spreadsheet-based analysis tool that can be utilized to estimate the user benefits of particular ITS applications, according to the user's manual and other information provided at FHWA's SCRITS website (http://www.fhwa.dot.gov/steam/scrits.htm). SCRITS is intended to be used as a sketch-level analysis tool that will enable planners and consultants to identify some of the possible benefits that would accrue due to the deployment of one of the included ITS technologies; as such, it is not intended for detailed analysis. When greater accuracy is necessary, the manual suggests the utilization of more sophisticated analysis tools such as simulation models or IDAS.

SCRITS was originally developed to address "the need for simplified estimates in the early stages of ITS-related planning, in the context of either a focused ITS analysis, a corridor/subarea transportation study, or regional planning analysis."[26] The following principles guided the development process of this particular tool:

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[26] *User's Manual for SCRITS, SCReening Analysis for ITS*, prepared by Science Applications International Corporation for the U.S. Department of Transportation, Federal Highway Administration, Office of Traffic Management and ITS Applications, January 1999.

- results should be compatible with transportation analyses conducted using other types of tools, such as travel demand models or simulation applications;
- analysis should be adaptable to regional, facility, and subarea scales;
- analysis should produce estimates of benefits on a daily basis (as opposed to estimates for individual peak periods or peak hours); and
- analyst must recognize that there is a great deal of uncertainty regarding the effects of ITS applications.

Microsoft Excel for Office 97 was used to create the SCRITS analysis tool, which is structured in a workbook format that consists of a series of worksheets. One worksheet is provided for users to provide a set of baseline data, such as a definition of the study area and related travel statistics (e.g., VMT estimates). Several other worksheets include lookup tables from which information is drawn that is utilized in the various analyses of the ITS applications. The remaining worksheets in the workbook are used to analyze and estimate benefits for the 16 individual ITS applications contained in the spreadsheet tool. Among the ITS technologies included in the SCRITS tool are Closed Circuit TV, Highway Advisory Radio, Variable Message Signs, and Electronic Toll Collection. Three of the application spreadsheets are related specifically to transit: Automatic Vehicle Location System for Buses, Electronic Fare Collection for Buses, and Signal Priority Systems for Buses. Unfortunately, as it is currently structured, the SCRITS tool does not accommodate analysis for combinations of ITS strategies.

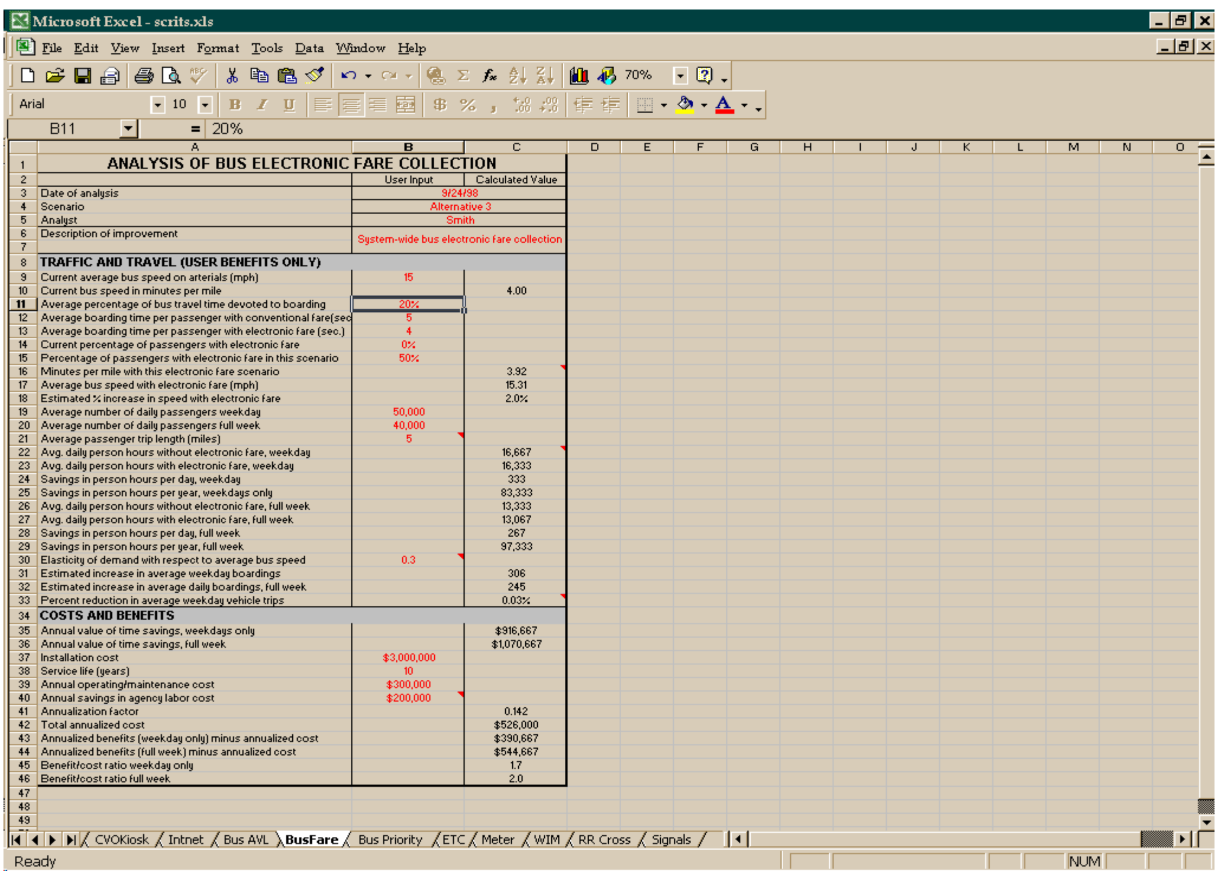
To analyze a particular ITS application, the user must input baseline data into the appropriate worksheet, then fill in all of the required data items on the worksheet associated with the application being analyzed. It also is necessary to provide all cost estimates (e.g., construction, installation, and/or operations/maintenance) and the service life of the technology. Utilizing this information, SCRITS then calculates a number of measures of effectiveness (which vary by ITS application), including:

- changes in VHT (for most applications);
- changes in VMT, where applicable;
- changes in emissions (CO, Nox, HC), where applicable;
- changes in vehicle operating costs, where applicable;
- changes in energy consumption, where applicable;
- changes in the number of accidents, where applicable; and
- economic benefit and benefit/cost ratio (for most applications).

The SCRITS documentation does stress two caveats related to the use of the tool. First, it is important to recognize that SCRITS output is approximate and should be used for general planning purposes only. As mentioned previously, it is strictly a sketch-level planning tool. Given the uncertainty associated with travel delay and the numerous assumptions that are required in the worksheets and calculations to reasonably assess the accrual of ITS benefits, SCRITS can produce only a general approximation of these benefits. Second, it is important to note that SCRITS focuses on **user benefits only**. Resulting benefits to agency operations, such as labor efficiency and/or management effectiveness, are not accounted for in any of the worksheets, despite the fact that these benefits may be the most important reason for implementing the technology. This is especially the case for various transit management applications. For example, while electronic fare collection may provide passengers with a greater variety of fare options and faster boarding times, a transit agency will benefit significantly from the reduction of cash transactions and the increased automation of its accounting system.

An example of one of the SCRITS analysis worksheets is shown in Figure 3. The figure depicts the worksheet that can be utilized to assess the benefits of Electronic Fare Collection for Buses.

Figure 3-3
Screen Capture of SCRITS Electronic Fare Collection Worksheet



	A	B	C
1	ANALYSIS OF BUS ELECTRONIC FARE COLLECTION		
2		User Input	Calculated Value
3	Date of analysis	9/24/98	
4	Scenario	Alternative 3	
5	Analyst	Smith	
6	Description of improvement	System-wide bus electronic fare collection	
7			
8	TRAFFIC AND TRAVEL (USER BENEFITS ONLY)		
9	Current average bus speed on arterials (mph)	15	
10	Current bus speed in minutes per mile		4.00
11	Average percentage of bus travel time devoted to boarding	20%	
12	Average boarding time per passenger with conventional fare(sec	5	
13	Average boarding time per passenger with electronic fare (sec.)	4	
14	Current percentage of passengers with electronic fare	0%	
15	Percentage of passengers with electronic fare in this scenario	50%	
16	Minutes per mile with this electronic fare scenario		3.92
17	Average bus speed with electronic fare (mph)		15.31
18	Estimated % increase in speed with electronic fare		2.0%
19	Average number of daily passengers weekday	50,000	
20	Average number of daily passengers full week	40,000	
21	Average passenger trip length (miles)	5	
22	Avg. daily person hours without electronic fare, weekday		16,667
23	Avg. daily person hours with electronic fare, weekday		16,333
24	Savings in person hours per day, weekday		333
25	Savings in person hours per year, weekdays only		83,333
26	Avg. daily person hours without electronic fare, full week		13,333
27	Avg. daily person hours with electronic fare, full week		13,067
28	Savings in person hours per day, full week		267
29	Savings in person hours per year, full week		97,333
30	Elasticity of demand with respect to average bus speed	0.3	
31	Estimated increase in average weekday boardings		306
32	Estimated increase in average daily boardings, full week		245
33	Percent reduction in average weekday vehicle trips		0.03%
34	COSTS AND BENEFITS		
35	Annual value of time savings, weekdays only		$916,667
36	Annual value of time savings, full week		$1,070,667
37	Installation cost	$3,000,000	
38	Service life (years)	10	
39	Annual operating/maintenance cost	$300,000	
40	Annual savings in agency labor cost	$200,000	
41	Annualization factor		0.142
42	Total annualized cost		$526,000
43	Annualized benefits (weekday only) minus annualized cost		$390,667
44	Annualized benefits (full week) minus annualized cost		$544,667
45	Benefit/cost ratio weekday only		1.7
46	Benefit/cost ratio full week		2.0

Rationale for the Selection of SCRITS

As mentioned previously, it was determined that the SCRITS tool would be utilized to conduct the case study analyses for the five transit systems. Although it is a less sophisticated sketch-level analysis tool, SCRITS was chosen over IDAS for a number of reasons, including the following:

- IDAS is a more complex analysis tool that will require a higher learning curve for proper utilization;
- IDAS requires more intensive data inputs, including modal split and traffic assignment outputs from existing travel demand forecasting models;
- the SCRITS tool, available free of charge, is an Excel-based spreadsheet – software that is readily available at most, if not all, transit systems in Florida;
- the IDAS tool is a stand-alone software package that costs $795; and
- the IDAS software requires more significant base computer requirements than does SCRITS.

The general review of the tools' capabilities, as indicated in their respective documentation, suggests that the IDAS tool is the more valuable and in-depth planning and assessment tool, assuming that a transit agency is willing to spend the time, money, and effort to acquire it, learn to use it, and apply it properly. However, it is anticipated that the SCRITS tool will be more well-received at the individual transit agencies as a potential pre-deployment planning analysis tool. It will be easier to acquire and will not require nearly as much staff time as IDAS to understand make use of the tool. Nevertheless, it is important to remember that the SCRITS tool is only able to analyze "user" benefits, and only for three different APTS components (automatic vehicle location, electronic fare collection, and signal priority).

Participating Transit Agencies

As indicated previously, it was decided that five separate case studies would be conducted involving the following systems: Pinellas Suncoast Transit Authority, Hillsborough Area Regional Transit Authority, LYNX Transit, and Sarasota County Area Transit in Florida, and Ann Arbor Transportation Authority in Michigan. Four of the five systems currently utilize electronic fare collection, and the other system (Sarasota) is in the process of implementing it. In addition, LYNX and Ann Arbor also have in place AVL systems and utilize bus priority. The following sections provide brief synopses of the systems and their respective ITS component(s).

Pinellas Suncoast Transit Authority

Pinellas Suncoast Transit Authority (PSTA) is an independent authority and was created by special act of the Florida Legislature (Chapter 70-907, House Bill No. 5465). The system provides fixed-route motorbus and demand-response services throughout most of Pinellas County, with Kenneth City, Bellair Beach, Bellair Shores, Treasure Island, and St. Pete Beach as the only exceptions. NTD information for the 1999 fiscal year indicates that PSTA's service area encompasses approximately 209 square miles, with a total population of 833,500 persons. Fixed-route motorbus service is provided seven days per week through the use of 115 vehicles operating in peak service. In FY 1999, PSTA buses carried a total of 9.3 million passenger trips while operating nearly 6.6 million revenue miles of service.

According to the initial APTS inventory survey, PSTA currently is not in the planning stages for the implementation of any new APTS technologies. However, the system already has in place an electronic fare payment system and an advanced communications system. PSTA is utilizing a Motorola (analog land mobile) radio system on its vehicles, and expects to eventually upgrade that system to a more advanced one from Motorola that will incorporate AVL, as well. The system also has CENTSaBILL electronic registering farebox units from GFI Genfare on its entire fleet, along with accompanying GFI TRiM (Ticket Reader/Issue Machine) units.

The farebox units, which have been in use since 1989, enable the rapid collection and registering of cash and token fares. An integrated keypad also allows drivers to record special fares, as well. PSTA added the TRiM units in 1995 and began utilizing magnetic stripe cards at that time. The TRiM unit is able to process (i.e., read/validate, print/issue) all types of magnetic documents, including magnetic tickets/passes and transfers. The capabilities of the units also allow a transit system to add stored-value or stored-ride tickets to their fare media mix. PSTA has made use of the units' capabilities by offering rolling 7-day and 31-day fare cards (i.e., cards that do not register the start date for valid use until the first time that they are utilized in a TRiM unit).

According to PSTA, the CENTSaBILL fareboxes and accompanying TRiM units currently are being upgraded. The system is replacing them with GFI's new Genfare Odyssey Electronic Revenue Center fareboxes (all-in-one registering farebox and ticket reader unit). Genfare product information for the Odyssey indicates that this system provides improved data registration, security, and ease of operations. It also supports the optional use of credit cards, proximity smartcards, and employer ID programs. Some of the GFI Odyssey's features include:

- accepts and validates coins and bills; returns unacceptable coins and bills to passengers;

- accepts and processes all types of magnetic stripe paper and plastic farecards and passes;
- issues, prints, and encodes machine readable transfers from blank stock stored internally;
- accepts and automatically validates transfers issued by other Odyssey units;
- has built-in provisions for non-contact smartcard operations;
- has provision for credit card fare payment options, such as Visa/MasterCard;
- allows for multi-level fare tables for passenger categories, time differentials, zone options and fare media type;
- provides change and on-board card upgrades by cash-to-card conversion;
- includes passenger displays to show transactions and remaining card value; and
- provides optional interface to destination/next stop electronic signs/audio annunciator system; GPS; passenger counters; and on-board bus computer systems.

Hillsborough Area Regional Transit Authority

The Hillsborough Area Regional Transit Authority (HART) is an independent authority that provides fixed-route motorbus and demand response services to all of Hillsborough County (excluding Plant City). According to FY 1999 National Transit Database (NTD) information (the most recent year for which validated NTD data are available), HART's service area encompasses approximately 273 square miles, with a service area population totaling over 922,000 persons. Fixed-route motorbus service is provided seven days per week using a peak fleet of 158 vehicles. HART's fixed-route service provided more than 5.4 million revenue miles of service in FY 1999, generating a total of 9.3 million passenger trips.

The results of the initial APTS inventory survey indicate that HART is in the planning stages for a number of APTS technologies, some of which are already moving to the operational phase. Some of these technologies include AVL, vehicle component monitoring, automated operations software, on-board safety systems, trip planning information, and advanced communications, among others. Two technologies that are fully operational are HART's multi-carrier reservation and billing system and its automated paratransit system (which includes automated scheduling and computer-aided dispatch). In addition, HART is utilizing an electronic fare payment system on board its vehicles. Similar to PSTA, the system is utilizing CENTSaBILL electronic registering fareboxes from GFI Genfare on its motorbuses.

The electronic farebox units, which replaced the system's Duncan drop-style cash boxes, were installed in 1989. The GFI TRiM units were integrated in 1998 (HART is utilizing the updated, second-design units, TRiM2). With the advent of the TRiM units, HART began making magnetic stripe cards available for use. Currently, a one-day unlimited ride fare card can be purchased on any bus. In addition, HART also offers non-rolling 5-day and 31-day unlimited use fare cards; however, these fare media are available only at authorized sales outlets.

LYNX Transit

LYNX Transit is an independent authority that provides fixed-route motorbus, demand response, and vanpool services to a three-county region that includes Orange, Seminole, and Osceola Counties. The system also coordinates a five-county regional ridesharing assistance program and transportation disadvantaged services for the region. According to FY 1999 NTD data, LYNX's service area covers more than 2,500 square miles and has a population of almost 1.4 million persons. Fixed-route motorbus service is provided seven days per week using a peak fleet of 168 vehicles. LYNX provided a total of 19.8 million passenger trips on its fixed-route service and more than 10.4 million revenue miles of service in FY 1999.

While LYNX did not participate in the initial APTS inventory survey, it is known that the system is utilizing electronic fare collection on its motorbuses, and AVL and bus prioritization for its LYMMO downtown circulator service. The electronic fare collection system consists of Genfare CENTSaBILL electronic registering fareboxes, which were installed in 1990. The system currently is taking advantage of the farebox's swipe card reader, offering both weekly and monthly (non-rolling) swipe passes. However, LYNX has not implemented TRiM units in any of its vehicles to date.

The LYMMO service is free, so the GFI fareboxes on board the LYMMO buses are used only to count passengers (i.e., a driver uses the keypad on the unit to enter in the number of persons boarding at each stop). LYMMO, however, does make use of AVL and bus priority technologies. A computerized bus detection system utilizing vehicle-based transponders and loop detectors at various locations along the route is used to locate LYMMO buses along the circulator alignment. Information from this system then is used as input for the passenger advisory system (i.e., station kiosks with electronic maps and variable message signs, and an audio broadcast system), which provides persons waiting at stations with real-time bus information.

In addition, loop-actuated bus-only signals have been integrated with traffic control at 11 intersections along the circulator alignment for the provision of signal priority for LYMMO. The loop detectors in the exclusive bus lane activate a special bus-only phase at those signalized intersections where the bus cannot proceed along the exclusive bus lane with the general traffic phase.

Sarasota County Area Transit

Sarasota County Area Transit (SCAT) is the informal designation for the Sarasota County Transportation Authority, which functionally operates as the Transit Department of Sarasota County government. SCAT is governed by the Sarasota County Board of County Commissioners and provides fixed-route motorbus and demand-response services to the urbanized portion of the county, including the cities of Sarasota, Venice, Englewood, and North Port, and the Town of Longboat Key. Information from the FY 1999 NTD indicates that SCAT's service area has a total population of 272,000 persons and is approximately 159 square miles in size. Fixed-route motorbus service is provided Monday through Saturday from 5:00 a.m. to 8:00 p.m., using a peak fleet of 26 vehicles. In FY 1999, a total of 1.6 million passenger trips were carried on SCAT buses, which operated a total of 1.5 million revenue miles of service during this fiscal year.

As noted in the first chapter, SCAT is in the planning stages for a number of APTS technologies, including automated operations software, AVL, trip planning information, automated service coordination, and the development of a TMC, among others. The only technology that currently is fully operational is SCAT's advanced communications system (Motorola 800 MHz trunked radio system). However, SCAT is now in the process of implementing an electronic fare payment system on its entire fleet. In October 2000, the system replaced the GFI Genfare non-registering farebox units (i.e., simple drop box for cash fare collection) on its 42-vehicle fleet with validating farebox units from Agent Systems, Inc. The new units, called the SmartBox, electronically validate both coins and bills, rejecting counterfeits and slugs, and stack and face bills in the cashbox.

While these new fareboxes are operational now, SCAT will not be installing the companion SmartBox Magnetic Ticket Units (i.e., the electronic ticket reader) until the end of Summer 2001, at the earliest. One of the major benefits of these units is the ability to issue change in the form of reusable cash cards – a capability that SCAT looks forward to utilizing. The ticket units will be able to accept all forms of tickets and passes, and will even be able to issue and accept transfers. In effect, the integrated SmartBox farebox and ticket unit will allow each individual bus to become a full-service ticket and pass sales outlet.

Ann Arbor Transportation Authority

Ann Arbor Transit Authority (AATA, and also known as "The Ride") is an independent authority that was authorized by an act of the Michigan State Legislature in 1968 to provide public transportation services within Washtenaw County.[27] The system's Articles of Incorporation were created by the City of Ann Arbor, which authorized AATA to provide its services throughout Ann Arbor and beyond its corporate limits. Currently, AATA provides fixed-route motorbus and demand-response services within the Ann Arbor and Ypsilanti urbanized areas and in portions of the Ypsilanti, Pittsfield, and Superior Townships. AATA also coordinates a RideShare program, which facilitates carpool and vanpool services for commuters traveling within Washtenaw County, as well as for those persons traveling into the county from Southeast Michigan/Northwest Ohio. FY 1999 NTD data indicate that AATA's service area is 71 square miles in size with a total population of 189,200 persons. Fixed-route motorbus service is provided seven days per week with a peak vehicle requirement of 59 vehicles. In FY 1999, AATA provided a total of 4.0 million passenger trips on its fixed-route motorbus service; the system operated almost 2.3 million revenue miles of service during this time, as well.

According to information provided on AATA's web site (http://www.theride.org/aos.html), the system began implementing an Advanced Operating System (AOS) in the fall of 1996. This AOS, a fully integrated public transit communication, operation, and maintenance system, includes elements such as advanced communications, AVL, onboard emergency system, onboard en-route information, computer-assisted transfer management, automated paratransit reservations/scheduling, vehicle component monitoring, video surveillance, automated passenger counting, and electronic fare collection, among others.

According to staff, AATA currently is using Genfare CENTSaBILL electronic registering fareboxes on its vehicle fleet. These units were originally installed in 1984 and were utilized successfully through 1999, when AATA decided to upgrade its system. In February 2000, new electronic fareboxes from another vendor replaced all of the GFI units. Unfortunately, AATA had numerous operational and maintenance issues with the new units that were not satisfactorily addressed. Ultimately, the system had all of its original CENTSaBILL fareboxes rehabilitated by GFI; these were reinstalled on the bus fleet in January 2001. AATA has not implemented TRiM units in any of its vehicles to date, nor is the system taking advantage of the farebox's swipe card reader. Instead, AATA utilizes various multi-ride flash passes in addition to accepting cash for fare payment.

For vehicle location, the system is using Siemens GPS technology. The position of each vehicle can be calculated within one to two meters utilizing this system. The GPS signal also provides accurate time to the vehicles so that scheduled times and locations can be compared with actual times and

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[27] *AATA Strategic Plan: Destination 2010*, Ann Arbor Transportation Authority, http://www.theride.org/StragegicPlanText.html, adopted October 1999.

locations to determine real-time, on-time performance. The bus operator can be notified via a mobile display terminal (part of the advanced communications system) and the onboard computer whenever a bus is running late; the system is set up to notify AATA's Operation Center, as well. The AVL system also is set up to trigger external destination signs/announcements and the internal next-stop signs and announcements. In addition, it integrates location data with information from other onboard systems, such as fare collection, passenger counters, and component (i.e., engine) monitoring.

Application of SCRITS to Selected Transit Agencies

In this section, the data inputs for and the resulting outputs from the transit systems' SCRITS analyses are presented. Also discussed are any rationale provided by the systems for their respective user input estimates. The three transit-specific SCRITS worksheets, electronic fare collection, AVL, and bus priority, all are examined. The electronic fare collection analysis worksheet has been completed and is presented for all five case study transit systems: HART, PSTA, LYNX, SCAT, and AATA. The bus AVL analysis worksheet has been completed for LYNX and AATA, and the bus priority analysis worksheet has been completed for LYNX only; these are also presented in this section. To the extent possible, comparisons of the systems' cost/benefit results have been made and are provided in this section, as well.

As a caveat, it is important to keep in mind that SCRITS is supposed to be a sketch-level planning tool, as noted previously in its description. That is, it should be utilized to help estimate potential user-side benefits that may result from the implementation of a particular ITS technology – not necessarily for post-deployment evaluation. In this analysis, four of the five systems included as case studies already have in place the technologies that are being examined. Only SCAT is still in the process of deploying a particular technology (i.e., electronic fare collection). Therefore, with direction from FDOT, assessment of the SCRITS tool, by necessity, has had to utilize a methodology that does not conform to its original intended use.

This methodology consists of a pre- and post-deployment assessment of the SCRITS-derived user benefits associated with the implementation of the three transit-related ITS technologies. To this end, each case study transit system was asked to provide information for each of the worksheet data inputs for the pre-deployment and post-deployment cases of their respective ITS technologies. For the systems with technologies already in place, inputs for the pre-deployment case required staff to "assume" that a given technology was not yet in operation. They then were asked to provide best estimates for those inputs related to the technology's function based on their original expectations. For example, in the case of electronic fare collection, one of the inputs the systems were asked to provide is the percentage of passengers using electronic fare media. For this input, system staff had to disregard actual current electronic fare usage and, instead, provide what their expectation was for utilization before the new farebox system was implemented. The post-deployment case simply required the systems to provide actual data based on their current operating experience with a particular technology.[28]

It should be noted that in each of the technology worksheets, there are a number of operational inputs on which the three ITS technologies would be expected to have a less immediate impact. Variables such as average percentage of bus travel time devoted to boarding, average number of daily passengers, and daily vehicle trips on bus corridor, then, were kept constant between the two deployment cases to mitigate their impact on the benefits results (especially since numerous other factors unrelated to the deployment also could have had an impact on these variables). For example, the availability of electronic fare media ultimately may have an impact on daily ridership, but this effect would not be as immediate as that on average boarding times for passengers, which more directly affects the benefit of passenger time savings. As a result, in each of the worksheets the variable(s) most closely related to the function of the ITS technology were the only ones that were modified to represent "pre-deployment expected" and "post-deployment actual" values. In the case of electronic fare collection, these variables include average passenger boarding times (with conventional and electronic fare) and percentage of passengers with electronic fare. In the case of AVL, these variables include average wait time per passenger, average wait time with AVL, and percentage of passengers using AVL information. Finally, in the case of bus priority, these variables include percentage of bus travel time due to signal delay and percentage reduction in signal delay from pre-emption.

A final note involves a variable that is used in the electronic fare collection and bus priority worksheets, elasticity of demand with respect to average bus speed. This variable represents the estimated percentage increase in transit ridership that would be expected for each one percent increase in average bus speed. The default value utilized by SCRITS is 0.3 (according to FHWA staff, this value is based on national experience, but a reference for its origin could not be provided). This means that, if a system were able to implement improvements to its service that would increase average bus speed by 10 percent, ridership would be expected to increase by approximately 3 percent as a result. Since none of the systems included in this analysis have completed any elasticity studies related to bus speed, it was determined that each system's applicable analysis should utilize the default value of 0.3.

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[28] Since SCAT and AATA have not had any operational experience with electronic fare collection yet, the methodology for their analyses had to be modified further. SCAT and AATA staff still were required to provide pre-deployment estimates for the worksheet data inputs, but averages from the post-deployment experiences of the other three case study transit systems were utilized to estimate the key inputs for SCAT's and AATA's post-deployment condition. This variant methodology is discussed further in the sections detailing the SCRITS analyses for SCAT and AATA.

Pinellas Suncoast Transit Authority

PSTA planning staff was provided with the SCRITS spreadsheet tool and asked to provide pre- and post-implementation data for the system's electronic fare collection system for the tool's required user inputs. After PSTA staff provided the necessary information, a follow-up phone interview was utilized to validate and/or clarify the system's user inputs and to collect descriptive information about the electronic fare collection system (i.e., manufacturer, model, when implemented, electronic fare media being utilized, etc.). During that conversation, data were verified, corrected as needed, and finalized for inclusion in this analysis.

It should be noted that the SCRITS tool utilizes a number of baseline inputs (whose values are based on national norms, but can be modified to account for local/regional characteristics) that are utilized throughout the various ITS technology worksheets. One of these, the value of time per person hour, is used in the electronic fare collection worksheet. For the purpose of this analysis, a value of $10.85 per person hour was used for PSTA. This value reflects 80 percent of the 1998 average wage rate in the Tampa-St. Petersburg-Clearwater Metropolitan Statistical Area, based on average annual pay data from the *2000 Florida Statistical Abstract* (Table 6.57).[29]

Tables 3-1 and 3-2 reflect the user inputs and resulting calculated values for PSTA's pre- and post-deployment conditions, respectively. According to PSTA staff, average bus speed is 15 miles per hour, average passenger trip length is 5 miles, and the average percent of bus travel time that is devoted to boarding is approximately 50 percent. This last input value was estimated based on the revenue hours of service, ridership levels, and assumed passenger boarding times for several typical routes in the system. Average weekday ridership was indicated to be 35,000 and average daily ridership (including weekends) is about 29,400. PSTA also provided financial information for its electronic farebox system implementation. The total cost, including installation, was $2,055,000 and a useful service life of 10 years is expected for the equipment. PSTA staff estimated an annual operating/maintenance cost of

[29] According to the report, *Assessing the Benefits and Costs of ITS Projects: Volume 1 Methodology* (Gillen, Li, Dahlgren, and Chang, California PATH Program, Institute of Transportation Studies, University of California, Berkeley, UCB-ITS-PRR-99-9, March 1999), one of the alternative techniques that the Texas Transportation Institute recommends for estimating the value of time for evaluating projects is using 70 to 80 percent of the wage rate. Similarly, a model used by the Federal Highway Administration (FHWA) suggests the use of 80 percent of the average wage rate for both work and non-work travel (from *An Appraisal of Candidate Project Evaluation Measures*, an appendix to the FTA Policy Paper, *Revised Measures for Assessing Major Investments: A Discussion Draft*, September 1994). In this appendix, given the wide range in approaches to valuing travel time savings, FTA proposed valuing time at 80 percent of local wage rates to be consistent with FHWA practices until a uniform approach could be developed.

$200,000 for the system, but believe that the new system has resulted in $100,000 per year in labor cost savings.

The majority of the discussion with PSTA staff revolved around average boarding times and electronic fare utilization. Among the Florida systems analyzed herein, PSTA is unique in that the system implemented electronic fareboxes and integrated TRiM units at the same time to replace its non-registering drop boxes (which required a significantly higher level of driver involvement to complete each fare transaction). As a result, PSTA's average boarding time per passenger with conventional fare (e.g., cash, coins) dropped significantly from an estimated 9 seconds per transaction prior to implementation, to an estimated 5 seconds per transaction after deployment. For average boarding time per passenger with electronic fare, prior to deployment of the new fareboxes, PSTA had assumed a 50 percent reduction in boarding time for those passengers using electronic fare media as compared to those with conventional fare (i.e., 4.5 seconds, or 9 seconds × [1 - 0.5]). In reality, PSTA staff believe that boarding times for those using electronic fare media are even lower than anticipated: 3 seconds per transaction.

As for utilization of electronic fare media by its passengers, PSTA's pre-implementation estimate was relatively close to that which actually occurred after deployment. Prior to implementation, PSTA staff believed that approximately 30 percent of their passengers would make use of electronic fare media. Actually, after deployment of the new fareboxes and TRiM units, about 35 percent of ridership is paying for trips with electronic fare.

As shown in Table 3-1, application of PSTA's pre-deployment user inputs results in an annual value of time savings for its passengers of more than $2.9 million (over $2.4 million if only weekday service is included). The benefit/cost ratio for this technology for a full week is 7.4 (6.2 for weekdays only). These figures, then, are the estimated results that PSTA could expect from implementing electronic fare collection on board its vehicle fleet. Comparatively, using PSTA's post-deployment user inputs, it is evident in Table 3-2 that the actual value of time savings for the system's users is about $2.7 million (about $2.3 million for weekdays only). In addition, the benefit/cost ratio for a full week is 6.9 (5.8 for weekdays only).

These figures indicate that, when considering the case for a full week, PSTA's annual value of time savings and benefit/cost ratio both decreased approximately 6.7 percent between the "pre-deployment expected" and "post-deployment actual" values. The primary reason for this decline is the differences in the pre- and post-implementation average passenger boarding time estimates. For the pre-deployment condition, PSTA staff estimated 9-second boarding times for passengers with conventional fare and 4.5-second boarding times for passengers with electronic fare – a difference (i.e., time savings) of 4.5 seconds. In reality, PSTA staff believe that the incremental difference in boarding times between passengers with conventional fare and those with electronic fare is only about two seconds (5 seconds for conventional fare versus 3 seconds for electronic fare). This means that the time savings per electronic fare transaction decreased 1.5 seconds between what was expected and what was actually experienced after implementation. Nevertheless, these results indicate that all of PSTA's passengers are accruing significant benefits in terms of time savings because of the implementation of the electronic fare collection system and the resulting availability of electronic fare media.

Table 3-1
SCRITS Worksheet: Pre-Implementation Analysis of PSTA's Electronic Fare Collection

	User Input	Calculated Value
TRAFFIC AND TRAVEL (USER BENEFITS ONLY)		
Current average bus speed on arterials (mph)	15	
Current bus speed in minutes per mile		4.00
Average percentage of bus travel time devoted to boarding	50%	
Average boarding time per passenger with conventional fare (sec.)	9	
Average boarding time per passenger with electronic fare (sec.)	4.5	
Current percentage of passengers with electronic fare	0%	
Percentage of passengers with electronic fare in this scenario	30%	
Minutes per mile with this electronic fare scenario		3.70
Average bus speed with electronic fare (mph)		16.22
Estimated % increase in speed with electronic fare		8.1%
Average number of daily passengers weekday	35,000	
Average number of daily passengers full week	29,400	
Average passenger trip length (miles)	5	
Average daily person hours without electronic fare, weekday		11,667
Average daily person hours with electronic fare, weekday		10,792
Savings in person hours per day, weekday		875
Savings in person hours per year, weekdays only		224,875
Average daily person hours without electronic fare, full week		9,800
Average daily person hours with electronic fare, full week		9,065
Savings in person hours per day, full week		735
Savings in person hours per year, full week		268,275
Elasticity of demand with respect to average bus speed	0.3	
Estimated increase in average weekday boardings		851
Estimated increase in average daily boardings, full week		715
Percent reduction in average weekday vehicle trips		0.09%
COSTS AND BENEFITS		
Annual value of time savings, weekdays only		$2,439,894
Annual value of time savings, full week		$2,910,784
Installation cost	$2,055,000	
Service life (years)	10	
Annual operating/maintenance cost	$200,000	
Annual savings in agency labor cost	$100,000	
Annualization factor		0.142
Total annualized cost		$391,810
Annualized benefits (weekday only) minus annualized cost		$2,048,084
Annualized benefits (full week) minus annualized cost		$2,518,974
Benefit/cost ratio weekday only		6.2
Benefit/cost ratio full week		7.4

Table 3-2
SCRITS Worksheet: Post-Implementation Analysis of PSTA's Electronic Fare Collection

	User Input	Calculated Value
TRAFFIC AND TRAVEL (USER BENEFITS ONLY)		
Current average bus speed on arterials (mph)	15	
Current bus speed in minutes per mile		4.00
Average percentage of bus travel time devoted to boarding	50%	
Average boarding time per passenger with conventional fare (sec.)	5	
Average boarding time per passenger with electronic fare (sec.)	3	
Current percentage of passengers with electronic fare	35%	
Percentage of passengers with electronic fare in this scenario	35%	
Minutes per mile with this electronic fare scenario		3.72
Average bus speed with electronic fare (mph)		16.13
Estimated % increase in speed with electronic fare		7.5%
Average number of daily passengers weekday	35,000	
Average number of daily passengers full week	29,400	
Average passenger trip length (miles)	5	
Average daily person hours without electronic fare, weekday		11,667
Average daily person hours with electronic fare, weekday		10,850
Savings in person hours per day, weekday		817
Savings in person hours per year, weekdays only		209,883
Average daily person hours without electronic fare, full week		9,800
Average daily person hours with electronic fare, full week		9,114
Savings in person hours per day, full week		686
Savings in person hours per year, full week		250,390
Elasticity of demand with respect to average bus speed	0.3	
Estimated increase in average weekday boardings		790
Estimated increase in average daily boardings, full week		664
Percent reduction in average weekday vehicle trips		0.08%
COSTS AND BENEFITS		
Annual value of time savings, weekdays only		$2,277,234
Annual value of time savings, full week		$2,716,732
Installation cost	$2,055,000	
Service life (years)	10	
Annual operating/maintenance cost	$200,000	
Annual savings in agency labor cost	$100,000	
Annualization factor		0.142
Total annualized cost		$391,810
Annualized benefits (weekday only) minus annualized cost		$1,885,424
Annualized benefits (full week) minus annualized cost		$2,324,922
Benefit/cost ratio weekday only		5.8
Benefit/cost ratio full week		6.9

Hillsborough Area Regional Transit Authority

The SCRITS tool was provided to HART planning staff, who was then asked to review the spreadsheet's electronic fare collection worksheet and provide pre- and post-implementation data for that particular worksheet's required user inputs. After HART staff provided some preliminary information, a follow-up meeting was held at HART to review this information and collect other necessary input data for the analysis (at this meeting, a plan for HART to collect actual boarding time data also was discussed; subsequently implemented, results of this effort are discussed later in this section). Subsequent phone contact was needed to finalize the system's user inputs and to collect descriptive information about the electronic fare collection system (i.e., manufacturer, model, when implemented, electronic fare media being utilized, etc.). Additionally, as was the case for PSTA, the HART analysis utilized $10.85 to represent the value of time per person hour (i.e., 80 percent of the 1998 average wage rate in the Tampa-St. Petersburg-Clearwater Metropolitan Statistical Area).

The user inputs and resulting calculated values for HART's pre- and post-deployment conditions are shown in Tables 3-3 and 3-4, respectively. HART staff indicated that average bus speed is 13 miles per hour, average passenger trip length is 4.33 miles, and the average percent of bus travel time that is devoted to boarding is approximately 20 percent. The first two of these inputs are based on system operating data, while the third figure is an estimate HART staff based on knowledge of bus operations. Average weekday ridership was indicated to be 28,500 and average daily ridership (including weekends) is 23,100. The total cost, including installation, of HART's electronic farebox system implementation was $650,000. The anticipated useful service life of the equipment is five years and HART staff estimated an annual operating/maintenance cost of $65,000 for the system. HART staff did not believe that the new system resulted in any measurable labor cost savings.

Similar to the PSTA case study experience, most of the discussion of user inputs with HART involved average boarding times and electronic fare utilization. Unlike PSTA, HART implemented its TRiM units (in 1998) a number of years after installation of its electronic fareboxes (in 1989), so the disparity between conventional and electronic fare boarding times is not significant in the pre-deployment condition. According to estimates from HART staff, the average boarding time per passenger with conventional fare for this case was assumed to be about six seconds per transaction, while the average boarding time per passenger with electronic fare was assumed to be five seconds per transaction. However, further discussion of average boarding times, in general, and boarding time inputs for the post-deployment condition led HART staff to believe that they did not really have a grasp on actual passenger boarding times, regardless of payment method used. Therefore, HART volunteered to conduct a boarding time analysis (based on a process developed by CUTR) to develop improved estimates for the SCRITS analysis, as well as a better understanding of the boarding/fare payment process. According to the documentation[30] of HART's boarding time analysis, the boarding time average for passengers paying by cash was 11.56 seconds and for passengers paying by fare card was 7.25 seconds.[31] These, then, were the average boarding time inputs utilized for the post-deployment condition.

In discussing electronic fare utilization, HART staff indicated that, prior to implementation, it was expected that 30 percent of passengers would make use of electronic fare media. In actuality, after deployment of the TRiM units, 70 percent of HART's ridership is paying for trips with electronic fare.

As shown in Table 3-3, application of HART's pre-deployment user inputs results in an annual value of time savings for its passengers of more than $300,000 (about $263,000 if only weekday service is included). The benefit/cost ratio for this technology for a full week is 1.4 (1.2 for weekdays only). These are the estimated results that HART could expect from implementing electronic fare collection on board its vehicle fleet. Comparatively, HART's post-deployment user inputs result in an actual value of time savings for the system's users of about $1.6 million (about $1.4 million for weekdays only), as shown in Table 3-4. In addition, the benefit/cost ratio for a full week is 7.2 (6.2 for weekdays only).

When considering the case for a full week, HART's annual value of time savings and benefit/cost ratio both increased significantly (400+ percent in each case) between the "pre-deployment expected" and "post-deployment actual" values. The primary reasons for the increase are the differences in the pre- and post-implementation average passenger boarding time and electronic fare use estimates. For the pre-deployment condition, the difference in estimated average boarding times (i.e., time savings) is only one second, while the difference in post-deployment average boarding times is more than four seconds. This means that the time savings per electronic fare transaction increased more than three seconds between what was expected and what was actually experienced after implementation. In addition, the percent of passengers with electronic fare more than doubled from 30 percent to 70 percent between what was expected and what actually occurred. Regardless of these differences, though, like PSTA's situation, HART's passengers are benefitting in terms of time savings because of the electronic fare collection system deployment and the resulting availability of electronic fare media.

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30 *Impact of Electronic Fare Card on Boarding Times*, Hillsborough Area Regional Transit Authority, Tampa, FL, July 13, 2001.

31 Interestingly, it was determined that the typical fare transaction took several seconds longer than staff anticipated because of the number of transactions that involved a conversation between the passenger and the driver. The average boarding time for transactions without conversation was 6.25 seconds, while transactions with conversation took 13.55 seconds, on average.

Table 3-3
SCRITS Worksheet: Pre-Implementation Analysis of HART's Electronic Fare Collection

	User Input	Calculated Value
TRAFFIC AND TRAVEL (USER BENEFITS ONLY)		
Current average bus speed on arterials (mph)	13	
Current bus speed in minutes per mile		4.62
Average percentage of bus travel time devoted to boarding	20%	
Average boarding time per passenger with conventional fare (sec.)	6	
Average boarding time per passenger with electronic fare (sec.)	5	
Current percentage of passengers with electronic fare	0%	
Percentage of passengers with electronic fare in this scenario	30%	
Minutes per mile with this electronic fare scenario		4.57
Average bus speed with electronic fare (mph)		13.13
Estimated % increase in speed with electronic fare		1.0%
Average number of daily passengers weekday	28,500	
Average number of daily passengers full week	23,100	
Average passenger trip length (miles)	4.33	
Average daily person hours without electronic fare, weekday		9,493
Average daily person hours with electronic fare, weekday		9,398
Savings in person hours per day, weekday		95
Savings in person hours per year, weekdays only		24,206
Average daily person hours without electronic fare, full week		7,694
Average daily person hours with electronic fare, full week		7,617
Savings in person hours per day, full week		77
Savings in person hours per year, full week		28,083
Elasticity of demand with respect to average bus speed	0.3	
Estimated increase in average weekday boardings		86
Estimated increase in average daily boardings, full week		70
Percent reduction in average weekday vehicle trips		0.01%
COSTS AND BENEFITS		
Annual value of time savings, weekdays only		$262,639
Annual value of time savings, full week		$304,705
Installation cost	$650,000	
Service life (years)	5	
Annual operating/maintenance cost	$65,000	
Annual savings in agency labor cost	$0	
Annualization factor		0.244
Total annualized cost		$223,600
Annualized benefits (weekday only) minus annualized cost		$39,039
Annualized benefits (full week) minus annualized cost		$81,105
Benefit/cost ratio weekday only		1.2
Benefit/cost ratio full week		1.4

Table 3-4

SCRITS Worksheet: Post-Implementation Analysis of HART's Electronic Fare Collection

	User Input	Calculated Value
TRAFFIC AND TRAVEL (USER BENEFITS ONLY)		
Current average bus speed on arterials (mph)	13	
Current bus speed in minutes per mile		4.62
Average percentage of bus travel time devoted to boarding	20%	
Average boarding time per passenger with conventional fare (sec.)	11.6	
Average boarding time per passenger with electronic fare (sec.)	7.2	
Current percentage of passengers with electronic fare	70%	
Percentage of passengers with electronic fare in this scenario	70%	
Minutes per mile with this electronic fare scenario		4.37
Average bus speed with electronic fare (mph)		13.73
Estimated % increase in speed with electronic fare		5.6%
Average number of daily passengers weekday	28,500	
Average number of daily passengers full week	23,100	
Average passenger trip length (miles)	4.33	
Average daily person hours without electronic fare, weekday		9,493
Average daily person hours with electronic fare, weekday		8,989
Savings in person hours per day, weekday		504
Savings in person hours per year, weekdays only		128,544
Average daily person hours without electronic fare, full week		7,694
Average daily person hours with electronic fare, full week		7,285
Savings in person hours per day, full week		409
Savings in person hours per year, full week		149,132
Elasticity of demand with respect to average bus speed	0.3	
Estimated increase in average weekday boardings		479
Estimated increase in average daily boardings, full week		389
Percent reduction in average weekday vehicle trips		0.05%
COSTS AND BENEFITS		
Annual value of time savings, weekdays only		$1,394,704
Annual value of time savings, full week		$1,618,087
Installation cost	$650,000	
Service life (years)	5	
Annual operating/maintenance cost	$65,000	
Annual savings in agency labor cost	$0	
Annualization factor		0.244
Total annualized cost		$223,600
Annualized benefits (weekday only) minus annualized cost		$1,171,104
Annualized benefits (full week) minus annualized cost		$1,394,487
Benefit/cost ratio weekday only		6.2
Benefit/cost ratio full week		7.2

LYNX Transit

The SCRITS tool also was provided to LYNX planning staff; however, they were asked to review three of the tool's worksheets (electronic fare collection, automatic vehicle location and information, and bus priority systems) and provide pre- and post-implementation data for the required user inputs for each. Initially, a meeting was held at LYNX to provide the SCRITS spreadsheet and discuss the use of the tool. Subsequent phone contact with various staff was necessary to collect and/or verify the system's user inputs, as well as to gather descriptive information about the electronic fare collection system (i.e., manufacturer, model, when implemented, electronic fare media being utilized, etc.) and the other two technologies. It was even the case that City of Orlando Traffic Department staff was contacted to retrieve various traffic and cost data for the AVL and priority technologies. It also is important to note that this analysis utilizes $10.68 to represent the value of time per person hour (i.e., 80 percent of the 1998 average wage rate in the Orlando Metropolitan Statistical Area) and 1.2 to represent the average daily vehicle occupancy for daily automobile trips (needed as a baseline input for the bus priority worksheet, this value was estimated by LYNX staff and supported by City of Orlando Traffic Department staff).

The user inputs and resulting calculated values for the pre-and post-deployment conditions for LYNX's electronic fare payment system are shown in Tables 3-5 and 3-6, respectively. LYNX staff indicated that average bus speed is 15 miles per hour, the average passenger trip length is 6.4 miles, and the average percent of bus travel time that is devoted to boarding is approximately 25 percent. The first two of these inputs are based on system operating data, while the third figure is a LYNX staff estimate based on knowledge of the system's bus operations. Average weekday ridership was indicated to be 70,000 and average daily ridership (including weekends) is 59,300. The total cost, including installation, of LYNX's electronic registering fareboxes was estimated at about $900,000 (recall that the system currently is not utilizing integrated TRiM units). The anticipated useful service life of the equipment was estimated to be between 10 and 12 years, so a value of 11 years was utilized in the analysis. In addition, LYNX staff estimated an annual operating/maintenance cost of $40,000 for the system, but were not sure if its use resulted in any measurable labor cost savings (therefore, a value of zero dollars was used).

Average boarding times and extent of electronic fare utilization were also discussed with LYNX staff. According to their estimates, the average boarding time per passenger with conventional fare is six seconds per transaction. For the pre-deployment case, staff indicated that about a two-second time savings was anticipated with the use of the swipe passes, so the average boarding time per passenger with electronic fare for this case was assumed to be four seconds per transaction. Additionally, staff believe that this estimate also is representative of post-deployment average boarding times for passengers using electronic fare media, so the four-second per transaction figure was utilized for this case, as well.

As for the percentage of passengers utilizing electronic fare, LYNX staff indicated that the pre-implementation expectation for the proportion of ridership that would make use of electronic fare media was 40 percent. In actuality, after deployment of the electronic fareboxes, only 26 percent of LYNX's ridership is paying for trips with electronic swipe passes.

According to the information in Table 3-5, application of LYNX's pre-deployment user inputs results in an annual value of time savings for its passengers of more than $3.3 million (about $2.7 million if only weekday service is included). The benefit/cost ratio for this technology for a full week is 20.6 (17.1 for weekdays only). These are the estimated results that LYNX could expect from implementing electronic fare collection on board its vehicle fleet. Comparatively, as indicated in Table 3-6, LYNX's post-deployment user inputs result in an actual value of time savings for the system's users of about $2.1 million (about $1.8 million for weekdays only). In addition, the post-deployment benefit/cost ratio for a full week is 13.4 (11.1 for weekdays only).

Examination of the case for a full week shows that LYNX's annual value of time savings and benefit/cost ratio both decreased about 35 percent between the "pre-deployment expected" and "post-deployment actual" values. Since the average boarding times for conventional and electronic fare usage are identical between the two cases, the reason for this decline is LYNX's electronic fare use estimates. Originally, LYNX expected swipe pass utilization to reach 40 percent. However, after deployment of the new fareboxes, the percent of passengers with electronic fare is only 26 percent, a 35 percent drop between the anticipated utilization level and that which actually occurred. Regardless of this issue, though, it is still the case that, according to the post-deployment SCRITS analysis, LYNX's passengers are benefitting in terms of time savings because of the electronic fareboxes and the resulting availability of the weekly and monthly swipe passes.

Table 3-5
SCRITS Worksheet: Pre-Implementation Analysis of LYNX's Electronic Fare Collection

	User Input	Calculated Value
TRAFFIC AND TRAVEL (USER BENEFITS ONLY)		
Current average bus speed on arterials (mph)	15	
Current bus speed in minutes per mile		4.00
Average percentage of bus travel time devoted to boarding	25%	
Average boarding time per passenger with conventional fare (sec.)	6	
Average boarding time per passenger with electronic fare (sec.)	4	
Current percentage of passengers with electronic fare	0%	
Percentage of passengers with electronic fare in this scenario	40%	
Minutes per mile with this electronic fare scenario		3.87
Average bus speed with electronic fare (mph)		15.52
Estimated % increase in speed with electronic fare		3.4%
Average number of daily passengers weekday	70,000	
Average number of daily passengers full week	59,300	
Average passenger trip length (miles)	6.4	
Average daily person hours without electronic fare, weekday		29,867
Average daily person hours with electronic fare, weekday		28,871
Savings in person hours per day, weekday		996
Savings in person hours per year, weekdays only		255,858
Average daily person hours without electronic fare, full week		25,301
Average daily person hours with electronic fare, full week		24,458
Savings in person hours per day, full week		843
Savings in person hours per year, full week		307,833
Elasticity of demand with respect to average bus speed	0.3	
Estimated increase in average weekday boardings		724
Estimated increase in average daily boardings, full week		613
Percent reduction in average weekday vehicle trips		0.07%
COSTS AND BENEFITS		
Annual value of time savings, weekdays only		$2,732,561
Annual value of time savings, full week		$3,287,655
Installation cost	$900,000	
Service life (years)	11	
Annual operating/maintenance cost	$40,000	
Annual savings in agency labor cost	$0	
Annualization factor		0.133
Total annualized cost		$159,700
Annualized benefits (weekday only) minus annualized cost		$2,572,861
Annualized benefits (full week) minus annualized cost		$3,127,955
Benefit/cost ratio weekday only		17.1
Benefit/cost ratio full week		20.6

Table 3-6
SCRITS Worksheet: Post-Implementation Analysis of LYNX's Electronic Fare Collection

	User Input	Calculated Value
TRAFFIC AND TRAVEL (USER BENEFITS ONLY)		
Current average bus speed on arterials (mph)	15	
Current bus speed in minutes per mile		4.00
Average percentage of bus travel time devoted to boarding	25%	
Average boarding time per passenger with conventional fare (sec.)	6	
Average boarding time per passenger with electronic fare (sec.)	4	
Current percentage of passengers with electronic fare	26%	
Percentage of passengers with electronic fare in this scenario	26%	
Minutes per mile with this electronic fare scenario		3.91
Average bus speed with electronic fare (mph)		15.33
Estimated % increase in speed with electronic fare		2.2%
Average number of daily passengers weekday	70,000	
Average number of daily passengers full week	59,300	
Average passenger trip length (miles)	6.4	
Average daily person hours without electronic fare, weekday		29,867
Average daily person hours with electronic fare, weekday		29,220
Savings in person hours per day, weekday		647
Savings in person hours per year, weekdays only		166,308
Average daily person hours without electronic fare, full week		25,301
Average daily person hours with electronic fare, full week		24,753
Savings in person hours per day, full week		548
Savings in person hours per year, full week		200,091
Elasticity of demand with respect to average bus speed	0.3	
Estimated increase in average weekday boardings		465
Estimated increase in average daily boardings, full week		394
Percent reduction in average weekday vehicle trips		0.05%
COSTS AND BENEFITS		
Annual value of time savings, weekdays only		$1,776,165
Annual value of time savings, full week		$2,136,976
Installation cost	$900,000	
Service life (years)	11	
Annual operating/maintenance cost	$40,000	
Annual savings in agency labor cost	$0	
Annualization factor		0.133
Total annualized cost		$159,700
Annualized benefits (weekday only) minus annualized cost		$1,616,465
Annualized benefits (full week) minus annualized cost		$1,977,276
Benefit/cost ratio weekday only		11.1
Benefit/cost ratio full week		13.4

LYNX staff also was asked to assist with a SCRITS analysis of the AVL system being utilized on the LYMMO downtown circulator service. The user inputs and resulting calculated values for the pre- and post-deployment conditions for the automatic vehicle location and information worksheet are shown in Tables 3-7 and 3-8, respectively. LYNX staff indicated LYMMO's average weekday daily boardings to be 4,000 and average daily boardings for a full week (i.e., including weekends) to be 3,100.

According to the City of Orlando Traffic Division and LYNX staff, the total cost (including installation) of LYNX's AVL and bus priority systems was approximately $1,000,000. Since the systems use a lot of the same infrastructure and equipment and were purchased together, it was difficult for staff to provide a cost breakdown for the two systems. The best estimate that could be provided is that each represented about 50 percent of the initial total cost. Therefore, $500,000 was used as the total cost for the LYMMO AVL system. The anticipated useful service life of the equipment was estimated to be between 8 and 10 years, so a value of 9 years was utilized in the analysis. Additionally, LYNX staff could not provide any information on annual operating/maintenance costs for the system, so a value of zero dollars was used. Similarly, a value of zero dollars also was used for annual savings in agency labor cost since staff did not believe that the use of AVL resulted in any measurable labor cost savings.

The three other user inputs needed for the AVL analysis worksheet include current average wait time per passenger, average wait time per passenger with the AVL system, and percent of passengers utilizing information from the AVL system (i.e., real-time information resulting from the AVL system that is displayed at various stops and/or transfer stations). These variables were also discussed with LYNX staff. For the pre-deployment case, LYNX had originally planned for 10-minute headways, so it was assumed that average wait time would be 10 minutes. By using the AVL-derived real-time information at the LYMMO stops, it was expected that passengers would wait only two minutes, on average. LYNX staff also expected that all (i.e., 100 percent) LYMMO passengers would make use of the available information.

During discussion of the post-deployment case, LYNX staff indicated that average wait times after deployment of the AVL system are actually around two minutes, regardless of whether the AVL-derived information is utilized or not. According to staff, the reason for this is that the LYMMO system is operating on such short (four-minute) headways. Because of the relatively short time span between successive vehicles, staff believe that passengers will not need or want to make use of the real-time information since the wait time is already so short. They believe the information kiosks now have become more of novelty than a needed source of real-time information for LYMMO vehicle arrival times. As a result, the post-deployment input for percent of passengers utilizing the AVL-derived information at the stops is only 60 percent.

Table 3-7
SCRITS Worksheet: <u>Pre-Implementation</u> Analysis of LYNX's Automatic Vehicle Location

	User Input	Calculated Value
TRAFFIC AND TRAVEL (USER BENEFITS ONLY)		
Current average wait time per passenger (min.)	10	
Average wait time with AVL system (min.)	2	
Average number of weekday daily boardings	4,000	
Average number of daily boardings, full week	3,100	
Percent of passengers that use the information	100%	
Hours of time saved per weekday		533
Hours of time saved per average day, full week		413
Hours of time saved per year, weekdays only		137,067
Hours of time saved per year, total		150,867
COSTS AND BENEFITS		
Annual value of time savings, weekdays only		$1,463,872
Annual value of time savings, full week		$1,611,256
Installation cost	$500,000	
Service life (years)	9	
Annual operating/maintenance cost	$0	
Annual savings in agency labor cost	$0	
Annualization factor		0.153
Total annualized cost		$76,500
Annualized benefits (weekday only) minus annualized cost		$1,387,372
Annualized benefits (full week) minus annualized cost		$1,534,756
Benefit/cost ratio weekday only		19.1
Benefit/cost ratio full week		21.1

According to Table 3-7, LYNX's pre-deployment user inputs result in an annual value of time savings for its passengers of more than $1.6 million (about $1.5 million if only weekday service is included). The benefit/cost ratio for this technology for a full week is 21.1 (19.1 for weekdays only). These are the estimated results that LYNX could expect from the implementation of AVL and provision of real-time information. Comparatively, the data in Table 3-8 show that LYNX's post-deployment user inputs result in no time savings for its users and a benefit/cost ratio of 0.0. These significant differences result from the fact that LYNX does not see any time savings for its passengers, in terms of average wait time, as a result of LYMMO's AVL system and the real-time information kiosks located at the LYMMO stations (i.e., average wait time is two minutes regardless of whether real-time information is available for LYMMO service).

Table 3-8
SCRITS Worksheet: Post-Implementation Analysis of LYNX's Automatic Vehicle Location

	User Input	Calculated Value
TRAFFIC AND TRAVEL (USER BENEFITS ONLY)		
Current average wait time per passenger (min.)	2	
Average wait time with AVL system (min.)	2	
Average number of weekday daily boardings	4,000	
Average number of daily boardings, full week	3,100	
Percent of passengers that use the information	60%	
Hours of time saved per weekday		0
Hours of time saved per average day, full week		0
Hours of time saved per year, weekdays only		0
Hours of time saved per year, total		0
COSTS AND BENEFITS		
Annual value of time savings, weekdays only		$0
Annual value of time savings, full week		$0
Installation cost	$900,000	
Service life (years)	11	
Annual operating/maintenance cost	$40,000	
Annual savings in agency labor cost	$0	
Annualization factor		0.153
Total annualized cost		$76,500
Annualized benefits (weekday only) minus annualized cost		-$76,500
Annualized benefits (full week) minus annualized cost		-$76,500
Benefit/cost ratio weekday only		0.0
Benefit/cost ratio full week		0.0

However, it is important to note that, since the average wait times used in this particular analysis are estimates based on staff experience and knowledge, it is possible that some time savings actually are accrued by passengers that rely on LYMMO's AVL-based real-time information. As seen in the HART case study, the perception of time (whether boarding time, wait time, or otherwise) may not always approximate the reality. For example, even if the information kiosks at the LYMMO stations were only utilized by 60 percent of passengers, but their use of this information saved them just one minute of wait time, then an annual time savings of nearly $121,000 would result for the full-week case, with a benefit/cost ratio of 1.6. In order to achieve the breakeven point between the total costs resulting from the AVL and information system and the users' time savings benefits (i.e., benefit/cost ratio of 1.0), LYMMO's passengers would need to save only 38 seconds of wait time from their use of the real-time information.

The LYMMO's bus priority system also was analyzed using the SCRITS tool. The user inputs and resulting calculated values for the pre- and post-deployment conditions for the bus priority system worksheet are shown in Tables 3-9 and 3-10, respectively. The number of miles on which priority treatment is implemented is three miles, since the LYMMO route is three miles long and it has bus priority signalization for various intersections along its entire length. A total of seven buses operate each weekday on the LYMMO route, and current average bus speed is approximately 7.5 miles per hour. LYNX staff also indicated that average passenger trip length for LYMMO service is 1.5 miles and that the service carries 4,000 weekday daily passengers, on average.

As discussed previously in LYNX's AVL analysis, the City of Orlando Traffic Division and LYNX staff indicated the total cost (including installation) of LYNX's AVL and bus priority systems to be approximately $1,000,000. Since 50 percent of this initial total cost was applied to the AVL system, the other half (i.e., $500,000) was used as the total cost for the bus priority system. The anticipated useful service life of the priority equipment was estimated to be between 8 and 10 years, so a value of 9 years was utilized in the analysis. Again, LYNX staff and Traffic Division staff could not provide any information on annual operating/maintenance costs for this system, so a value of zero dollars was used. In addition, LYNX staff indicated that LYMMO's current operating cost per bus route-hour is approximately $46.

Unlike the other two worksheets analyzed thus far, the bus priority worksheet also requires user inputs related to various traffic operations characteristics of the route(s) being analyzed. The four traffic operations variables that are needed as inputs include the number of daily vehicle trips on the corridor served by the priority route(s), the weekday daily volume of cross street traffic for the priority route(s), the percentage of traffic that incurs pre-emption delay, and the average delay time per pre-empted vehicle (in seconds). LYNX staff deferred to the expertise of the City of Orlando Traffic Division for this information. Discussion with Traffic Division staff found that about six percent of traffic incurs pre-emption delay due to the LYMMO priority system, and that the average delay time is around 15 seconds per pre-empted vehicle. For the traffic volume data, a website (http://www.ci.orlando.fl.us/departments/public_works/trans/counts/adt.pdf) was provided that included the most recent (i.e., October 4, 2000) available traffic approach counts for selected intersections throughout the City of Orlando. From this information, then, daily vehicle trips on the LYMMO corridor and weekday daily cross street volumes were estimated (62,700 and 66,400, respectively).

Only two other user inputs are needed for the bus priority analysis worksheet: the percentage of bus travel time that can be attributed to signal delay and the estimated percent reduction in signal delay that would result from the use of a priority system. These variables were discussed with LYNX staff, who indicated that, typically, about 35 percent of bus travel time results from having to wait at signals. This value was used in both the pre- and post-deployment cases since, like all of the other inputs discussed previously, it is assumed to remain constant between the two cases. In this worksheet, only the input for estimated reduction in signal delay actually varies. For the pre-deployment condition, LYNX staff indicated that, during development of the LYMMO system, the original expectation was a 50 percent reduction in signal delay because of the use of bus priority. In reality, however, staff believe that they have been able to achieve only a 25 percent reduction in signal delay.

Table 3-9 indicates that LYNX's pre-deployment user inputs result in a combined annual time savings for bus passengers and vehicle passengers (i.e., those persons in vehicles affected by the priority system's operation) of approximately $450,000. The corresponding benefit/cost ratio is 6.4. These are the estimated results that LYNX could expect from the implementation of a bus priority system. Comparatively, Table 3-10 shows that LYNX's post-deployment user inputs result in almost $180,000 in total bus passenger and vehicle passenger time savings, and a benefit/cost ratio of 2.4.

The pre- and post-deployment results indicate that the total annual time savings and benefit/cost ratio both decreased at least 60 percent between the "pre-deployment expected" and "post-deployment actual" values. This decline is directly attributable to the decrease in the estimated percent reduction in signal delay due to bus priority. As noted previously, LYNX expected a 50 percent reduction in signal delay, but actually only experienced about a 25 percent reduction after implementation of the priority system. Despite this decrease, though, LYMMO's priority system still is benefitting bus passengers in terms of their overall time savings.

Table 3-9
SCRITS Worksheet: <u>Pre-Implementation</u> Analysis of LYNX's Bus Priority System

	User Input	Calculated Value
BUS OPERATIONS, WEEKDAY ONLY		
Miles on which priority treatment is implemented	3	
Number of buses per weekday on priority routes	7	
Current average bus speed on arterials (mph)	7.5	
Percentage of bus travel time attributable to signal delay	35%	
Estimated % reduction in signal delay from pre-emption	50%	
Average minutes per mile for buses without priority		8.00
Average minutes per mile for buses with priority		6.60
Average bus speed with priority (mph)		9.09
Percentage increase in bus speed		21.2%
Number of route-hours saved per day		0.5
Number of route-hours saved per year, weekdays only		126
Number of daily passengers on affected routes	4,000	
Average passenger trip length (miles)	1.5	
Person hours without priority, weekday only		800
Person hours with priority, weekday only		660
Savings in person hours per weekday		140
Savings in person hours per year, weekdays only		51,100
Elasticity of demand with respect to average bus speed	0.3	
Estimated increase in average weekday passengers on route		255
Daily vehicle trips on corridor served by bus route(s)	62,700	
Percent reduction in vehicle trips in bus corridor		0.41%
Annual value of time savings for bus passengers		$545,748
TRAFFIC OPERATIONS		
Weekday daily volume of cross street traffic for entire route	66,400	
Percentage of traffic that incurs pre-emption delay	6%	
Average delay time per pre-empted vehicle (sec.)	15	
Additional vehicle hours delay per day to cross street traffic		17
Additional person hours delay per day		20
Additional person hours delay per year		7,271
Annual value of vehicle passenger time savings, weekdays only		-$93,183
COSTS AND BENEFITS		
Total of bus passenger and vehicle passenger time savings		$452,565
Installation cost	$500,000	
Service life (years)	9	
Annual operating/maintenance cost	$0	
Operating cost per bus route-hour	$46	
Annual bus operating cost savings		$5,793
Annualization factor		0.153
Total annualized cost		$70,707
Annualized benefits (weekday only) minus annualized cost		$381,858
Benefit/cost ratio weekday only		6.4

Table 3-10
SCRITS Worksheet: Post-Implementation Analysis of LYNX's Bus Priority System

	User Input	Calculated Value
BUS OPERATIONS, WEEKDAY ONLY		
Miles on which priority treatment is implemented	3	
Number of buses per weekday on priority routes	7	
Current average bus speed on arterials (mph)	7.5	
Percentage of bus travel time attributable to signal delay	35%	
Estimated % reduction in signal delay from pre-emption	25%	
Average minutes per mile for buses without priority		8.00
Average minutes per mile for buses with priority		7.30
Average bus speed with priority (mph)		8.22
Percentage increase in bus speed		9.6%
Number of route-hours saved per day		0.2
Number of route-hours saved per year, weekdays only		63
Number of daily passengers on affected routes	4,000	
Average passenger trip length (miles)	1.5	
Person hours without priority, weekday only		800
Person hours with priority, weekday only		730
Savings in person hours per weekday		70
Savings in person hours per year, weekdays only		25,550
Elasticity of demand with respect to average bus speed	0.3	
Estimated increase in average weekday passengers on route		115
Daily vehicle trips on corridor served by bus route(s)	62,700	
Percent reduction in vehicle trips in bus corridor		0.18%
Annual value of time savings for bus passengers		$272,874
TRAFFIC OPERATIONS		
Weekday daily volume of cross street traffic for entire route	66,400	
Percentage of traffic that incurs pre-emption delay	6%	
Average delay time per pre-empted vehicle (sec.)	15	
Additional vehicle hours delay per day to cross street traffic		17
Additional person hours delay per day		20
Additional person hours delay per year		7,271
Annual value of vehicle passenger time savings, weekdays only		-$93,183
COSTS AND BENEFITS		
Total of bus passenger and vehicle passenger time savings		$179,691
Installation cost	$500,000	
Service life (years)	9	
Annual operating/maintenance cost	$0	
Operating cost per bus route-hour	$46	
Annual bus operating cost savings		$2,896
Annualization factor		0.153
Total annualized cost		$73,604
Annualized benefits (weekday only) minus annualized cost		$106,088
Benefit/cost ratio weekday only		2.4

Sarasota County Area Transit

Similar to the other systems, SCAT planning staff was provided with the SCRITS spreadsheet tool and asked to review the tool's electronic fare collection worksheet. However, since the system has not yet implemented the companion electronic ticket reader units to its new Agent fareboxes, staff provided only pre-implementation data for that worksheet's required user inputs. SCAT was able to provide some of the necessary information initially, but several follow-up phone discussions were needed to collect the rest of the user inputs. This phone contact also provided an opportunity to validate and/or clarify the system's initial information, as well as to collect descriptive information about the new electronic fareboxes and planned ticket reader units (i.e., manufacturer, model, when implemented, plans for electronic fare media, etc.). For the purpose of SCAT's analysis, $9.70 was used to represent the value of time per person hour (i.e., 80 percent of the 1998 average wage rate in the Sarasota-Bradenton Metropolitan Statistical Area).

Table 3-11 presents the user inputs and resulting calculated values for SCAT's pre-deployment condition. According to SCAT staff, average bus speed is 20 miles per hour, average passenger trip length is 6.53 miles, and the average percent of bus travel time that is devoted to boarding is approximately 15 percent. The first two of these inputs are based on system operating data, while the third figure is an estimate SCAT staff based on knowledge of bus operations. Average weekday ridership was indicated to be 5,500 and average daily ridership (including weekends) is 5,250. SCAT also provided the total cost, including installation, for its electronic farebox system implementation ($540,000), as well as the expected useful service life of the equipment (10 years). However, since the fareboxes have only been in place for less than a year (and are still under warranty), staff did not have an estimate for what the annual operating/maintenance cost of the equipment would be in subsequent years. Since the system's current cost is zero, that is the value that was used in the worksheet. Similarly, zero dollars was used for the annual labor cost savings since SCAT staff expected that increased maintenance requirements would negate any potential savings from decreased fare administration requirements (e.g., cash handling/counting, security, etc.).

With regard to average boarding times, SCAT staff believe that the average boarding time per passenger with conventional fare is about seven seconds. Conversely, it was estimated that the average boarding time for passengers with electronic fare would be around 5 seconds. In addition, SCAT staff indicated that 20 percent of system ridership is expected to make use of electronic fare media once it is available for use on the SCAT system.

As mentioned previously in a footnote, analysis of SCAT's post-deployment condition required a variant methodology since the system has not had any operational experience with electronic fare collection yet. Like the other systems, many of the user inputs from the pre-deployment case were utilized for the post-deployment analysis without modification (e.g., ridership and financial information). However, the values for average boarding time with electronic fare and the percent of electronic fare use were derived using corresponding data from the post-deployment experiences of the other three Florida transit systems. For example, post-deployment average boarding times for passengers with electronic fare for PSTA, HART, and LYNX are 3 seconds, 7.2 seconds, and 4 seconds, respectively. The average of these values is 4.7 seconds; therefore, this is the value that was used for SCAT's post-deployment average boarding time for passengers with electronic fare. The systems' average for percent of passengers with electronic fare is approximately 44 percent. These values are reflected in SCAT's user inputs for its post-deployment analysis shown in Table 3-12.

In Table 3-11, it is evident that application of SCAT's pre-deployment user inputs results in an annual value of time savings for its passengers of just over $52,000 (about $38,000 if only weekday service is included). The benefit/cost ratio for this technology for a full week is 0.7 (0.5 for weekdays only). These values represent the estimated results that SCAT could expect from the implementation of electronic fare collection on its system. Comparatively, using post-deployment user inputs averaged from the experiences of the other three Florida properties, Table 3-12 shows that SCAT actually may attain almost $132,000 in time savings for its users (about $96,000 for weekdays only), once its electronic ticket readers are installed and operational. The benefit/cost ratio for this post-deployment case for a full week is 1.7 (1.3 for weekdays only).

These figures indicate that, when considering the case for a full week, SCAT's annual value of time savings and benefit/cost ratio both will be expected to increase more than 140 percent between the "pre-deployment expected" and "post-deployment actual" values if the system's experience with electronic fare media is similar to that of the average experience of the other Florida systems analyzed herein. Since SCAT's estimate of average boarding time for passengers with electronic fare (5 seconds) is quite similar to the average boarding time derived from the other three systems (4.7 seconds), the major reason for expecting such an increase is a higher electronic fare use estimate. SCAT expects a 20 percent utilization of electronic fare media; however, the other Florida systems experienced electronic fare usage ranging from 26 to 70 percent, with an average of 44 percent. Even if SCAT actually experiences electronic fare usage at the low end of this range (i.e., 26 percent), the benefit/cost ratio for the full week case would still be 1.0 – the breakeven point between the cost of the fare system and the time savings benefits accrued by system users.

Table 3-11
SCRITS Worksheet: Pre-Implementation Analysis of SCAT's Electronic Fare Collection

	User Input	Calculated Value
TRAFFIC AND TRAVEL (USER BENEFITS ONLY)		
Current average bus speed on arterials (mph)	20	
Current bus speed in minutes per mile		3.00
Average percentage of bus travel time devoted to boarding	15%	
Average boarding time per passenger with conventional fare (sec.)	7	
Average boarding time per passenger with electronic fare (sec.)	5	
Current percentage of passengers with electronic fare	0%	
Percentage of passengers with electronic fare in this scenario	20%	
Minutes per mile with this electronic fare scenario		2.97
Average bus speed with electronic fare (mph)		20.17
Estimated % increase in speed with electronic fare		0.9%
Average number of daily passengers weekday	5,500	
Average number of daily passengers full week	5,250	
Average passenger trip length (miles)	6.53	
Average daily person hours without electronic fare, weekday		1,796
Average daily person hours with electronic fare, weekday		1,780
Savings in person hours per day, weekday		15
Savings in person hours per year, weekdays only		3,910
Average daily person hours without electronic fare, full week		1,714
Average daily person hours with electronic fare, full week		1,699
Savings in person hours per day, full week		15
Savings in person hours per year, full week		5,363
Elasticity of demand with respect to average bus speed	0.3	
Estimated increase in average weekday boardings		14
Estimated increase in average daily boardings, full week		14
Percent reduction in average weekday vehicle trips		0.00%
COSTS AND BENEFITS		
Annual value of time savings, weekdays only		$37,923
Annual value of time savings, full week		$52,019
Installation cost	$540,000	
Service life (years)	10	
Annual operating/maintenance cost	$0	
Annual savings in agency labor cost	$0	
Annualization factor		0.142
Total annualized cost		$76,680
Annualized benefits (weekday only) minus annualized cost		-$38,757
Annualized benefits (full week) minus annualized cost		-$24,661
Benefit/cost ratio weekday only		0.5
Benefit/cost ratio full week		0.7

Table 3-12
SCRITS Worksheet: Post-Implementation Estimates for SCAT's Electronic Fare Collection

	User Input	Calculated Value
TRAFFIC AND TRAVEL (USER BENEFITS ONLY)		
Current average bus speed on arterials (mph)	20	
Current bus speed in minutes per mile		3.00
Average percentage of bus travel time devoted to boarding	15%	
Average boarding time per passenger with conventional fare (sec.)	7	
Average boarding time per passenger with electronic fare (sec.)	4.7	
Current percentage of passengers with electronic fare	0%	
Percentage of passengers with electronic fare in this scenario	44%	
Minutes per mile with this electronic fare scenario		2.93
Average bus speed with electronic fare (mph)		20.44
Estimated % increase in speed with electronic fare		2.2%
Average number of daily passengers weekday	5,500	
Average number of daily passengers full week	5,250	
Average passenger trip length (miles)	6.53	
Average daily person hours without electronic fare, weekday		1,796
Average daily person hours with electronic fare, weekday		1,757
Savings in person hours per day, weekday		39
Savings in person hours per year, weekdays only		9,891
Average daily person hours without electronic fare, full week		1,714
Average daily person hours with electronic fare, full week		1,677
Savings in person hours per day, full week		37
Savings in person hours per year, full week		13,568
Elasticity of demand with respect to average bus speed	0.3	
Estimated increase in average weekday boardings		37
Estimated increase in average daily boardings, full week		35
Percent reduction in average weekday vehicle trips		0.00%
COSTS AND BENEFITS		
Annual value of time savings, weekdays only		$95,946
Annual value of time savings, full week		$131,608
Installation cost	$540,000	
Service life (years)	10	
Annual operating/maintenance cost	$0	
Annual savings in agency labor cost	$0	
Annualization factor		0.142
Total annualized cost		$76,680
Annualized benefits (weekday only) minus annualized cost		$19,266
Annualized benefits (full week) minus annualized cost		$54,928
Benefit/cost ratio weekday only		1.3
Benefit/cost ratio full week		1.7

Ann Arbor Transportation Authority

To gain the perspective of a transit agency outside of Florida, AATA planning staff was provided the SCRITS tool and asked to review two of the tool's worksheets (electronic fare collection and automatic vehicle location and information) and provide pre- and post-implementation data for the required user inputs for each. The SCRITS spreadsheet was provided via e-mail and a phone interview was held to discuss the use of the tool and its various inputs. During this initial discussion, descriptive information about the electronic fare collection system (i.e., manufacturer, model, when implemented, electronic fare media being utilized, etc.) and the AVL system was gathered, as well. Subsequent phone contact was used to collect and/or verify the system's user inputs. For purposes of this analysis, $13.21 was used to represent the value of time per person hour (i.e., 80 percent of the 1998 average wage rate in the Ann Arbor, Michigan, Metropolitan Statistical Area).[32]

The user inputs and resulting calculated values for the pre- and post-deployment conditions for AATA's electronic fare payment system are shown in Tables 3-13 and 3-14, respectively. AATA's user inputs related to the operation of its bus service include an average bus speed of 13.9 miles per hour, an average passenger trip length of 3.34 miles, and an average percent of bus travel time that is devoted to boarding of approximately 25 percent. The first two of these inputs are based on system NTD operating statistics, while the third figure is an AATA staff estimate based on revenue hours of service, number of bus stops, number of round trips, and an average dwell time for boarding passengers at each stop for a typical route in the system. Average weekday ridership was indicated to be 15,000 and average daily ridership (including weekends) is 12,000. The total cost, including installation, of AATA's electronic registering fareboxes was estimated at about $782,000. The anticipated useful service life of the equipment was indicated to be 10 years. It was estimated by AATA staff that the annual operating/maintenance cost of the fareboxes is $183,000; however, it was indicated that there are no labor cost savings associated with the implementation (in fact, it was believed that the system actually may have resulted in some additional labor costs, though this increase could not be estimated so a value of zero dollars was used nonetheless).

Next, AATA staff were queried concerning the system's pre-implementation average boarding time and electronic fare utilization inputs. Since AATA makes use of a variety of multi-ride flash passes, it was necessary to account for their use in estimating the average boarding time per passenger with conventional fare. According to AATA staff, cash transactions average about 10 seconds while flash

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[32] *Statistical Abstract of the United States: 2000*, 120th Edition, U.S. Census Bureau, Washington, D.C., 2000.

pass transactions average only 2 seconds. Based on the current distribution of cash and pass users (about 50-50), the average boarding time for passengers with conventional fare is six seconds (i.e., 0.5× 10 + 0.5× 2). Staff then indicated that it was expected that the average boarding time per passenger with electronic fare would be approximately six seconds per transaction. As for the percentage of passengers utilizing electronic fare, AATA staff indicated that the pre-implementation expectation for the proportion of ridership that would make use of electronic fare media is 50 percent, or about the same proportion that is currently utilizing flash passes. The reason for this expectation is that AATA staff believe that all current flash pass users will switch over to electronic fare cards since the passes will be discontinued upon implementation of the electronic fare media.

Similar to the analysis for SCAT, a variant methodology had to be utilized for the analysis of AATA's post-deployment case since the system has not had any operational experience with electronic fare collection yet. As such, for this case, the values for average boarding time with electronic fare and the percent of electronic fare use were derived using corresponding data from the post-deployment experiences of the three case study transit systems already utilizing electronic fare media. Again, the average value for post-deployment average boarding times for passengers with electronic fare for PSTA, HART, and LYNX is 4.7 seconds. In addition, the systems' average for percent of passengers with electronic fare is approximately 44 percent. These values have been incorporated into AATA's post-deployment analysis and are reflected in the user inputs shown in Table 3-14.

The only other change in the inputs between the pre- and post-implementation analyses involves the average boarding time for passengers with conventional fare. As mentioned previously, it is expected that electronic fare media will replace AATA's current flash passes. This means that the definition of conventional fare will change for AATA in the post-deployment case (i.e., will only include cash). Therefore, a value of 10 seconds per transaction is utilized in this case to represent the average boarding time for passengers with conventional fare user input.

Table 3-13 shows that application of AATA's pre-deployment user inputs results in no annual time savings for its passengers and, therefore, a benefit/cost ratio for this technology of 0.0. This outcome is due to no expected time savings between conventional fare and electronic fare. According to AATA staff, one major concern of implementing electronic fare media is that, if it does replace the flash passes, it actually may serve to slow down overall average boarding times since the expectation is that having to swipe a card or insert it into a reader will take more time than simply "flashing" a pass at the driver. This expectation is revealed in AATA's estimations of average boarding times: two seconds for the flash pass and six seconds for an electronic fare card.

The AATA post-deployment analysis presented in Table 3-14, which utilizes post-deployment user inputs averaged from the experiences of the three case study transit systems currently using electronic fare media, indicates that AATA actually may attain more than $810,000 in time savings for its users (about $711,000 for weekdays only), once electronic fare media is made available. The benefit/cost ratio for this case for a full week is 2.8 (2.4 for weekdays only).

Based on these figures, then, if the system's experience with electronic fare media is similar to that of the average experience of the three "experienced" case study systems, AATA actually should realize annual time savings for its passengers and a positive benefit/cost despite the discontinuation of flash passes. The primary reason for this favorable projection is that the differential in average boarding times for passengers with conventional and electronic fare should be greater than AATA staff expects. Without flash pass use, average conventional fare boarding times should increase and the average electronic fare boarding time experienced at the other systems (4.7 seconds) is lower than that expected by AATA (6 seconds). Interestingly, AATA's actual results ultimately may even be higher than that shown in Table 3-14 since the other systems' average electronic fare utilization is 44 percent and AATA expects at least 50 percent electronic fare usage based on its passengers' current utilization of flash passes.

Table 3-13
SCRITS Worksheet: <u>Pre-Implementation</u> Analysis of AATA's Electronic Fare Collection

	User Input	Calculated Value
TRAFFIC AND TRAVEL (USER BENEFITS ONLY)		
Current average bus speed on arterials (mph)	13.9	
Current bus speed in minutes per mile		4.32
Average percentage of bus travel time devoted to boarding	25%	
Average boarding time per passenger with conventional fare (sec.)	6	
Average boarding time per passenger with electronic fare (sec.)	6	
Current percentage of passengers with electronic fare	0%	
Percentage of passengers with electronic fare in this scenario	50%	
Minutes per mile with this electronic fare scenario		4.32
Average bus speed with electronic fare (mph)		13.90
Estimated % increase in speed with electronic fare		0.0%
Average number of daily passengers weekday	15,000	
Average number of daily passengers full week	12,000	
Average passenger trip length (miles)	3.34	
Average daily person hours without electronic fare, weekday		3,604
Average daily person hours with electronic fare, weekday		3,604
Savings in person hours per day, weekday		0
Savings in person hours per year, weekdays only		0
Average daily person hours without electronic fare, full week		2,883
Average daily person hours with electronic fare, full week		2,883
Savings in person hours per day, full week		0
Savings in person hours per year, full week		0
Elasticity of demand with respect to average bus speed	0.3	
Estimated increase in average weekday boardings		0
Estimated increase in average daily boardings, full week		0
Percent reduction in average weekday vehicle trips		0.00%
COSTS AND BENEFITS		
Annual value of time savings, weekdays only		$0
Annual value of time savings, full week		$0
Installation cost	$782,000	
Service life (years)	10	
Annual operating/maintenance cost	$183,000	
Annual savings in agency labor cost	$0	
Annualization factor		0.142
Total annualized cost		$294,044
Annualized benefits (weekday only) minus annualized cost		-$294,044
Annualized benefits (full week) minus annualized cost		-$294,044
Benefit/cost ratio weekday only		0.0
Benefit/cost ratio full week		0.0

Table 3-14
SCRITS Worksheet: Post-Implementation Analysis of AATA's Electronic Fare Collection

	User Input	Calculated Value
TRAFFIC AND TRAVEL (USER BENEFITS ONLY)		
Current average bus speed on arterials (mph)	13.9	
Current bus speed in minutes per mile		4.32
Average percentage of bus travel time devoted to boarding	25%	
Average boarding time per passenger with conventional fare (sec.)	10	
Average boarding time per passenger with electronic fare (sec.)	4.7	
Current percentage of passengers with electronic fare	0%	
Percentage of passengers with electronic fare in this scenario	44%	
Minutes per mile with this electronic fare scenario		4.06
Average bus speed with electronic fare (mph)		14.76
Estimated % increase in speed with electronic fare		6.2%
Average number of daily passengers weekday	15,000	
Average number of daily passengers full week	12,000	
Average passenger trip length (miles)	3.34	
Average daily person hours without electronic fare, weekday		3,604
Average daily person hours with electronic fare, weekday		3,394
Savings in person hours per day, weekday		210
Savings in person hours per year, weekdays only		53,794
Average daily person hours without electronic fare, full week		2,883
Average daily person hours with electronic fare, full week		2,715
Savings in person hours per day, full week		168
Savings in person hours per year, full week		61,358
Elasticity of demand with respect to average bus speed	0.3	
Estimated increase in average weekday boardings		279
Estimated increase in average daily boardings, full week		223
Percent reduction in average weekday vehicle trips		0.03%
COSTS AND BENEFITS		
Annual value of time savings, weekdays only		$710,615
Annual value of time savings, full week		$810,545
Installation cost	$782,000	
Service life (years)	10	
Annual operating/maintenance cost	$183,000	
Annual savings in agency labor cost	$0	
Annualization factor		0.142
Total annualized cost		$294,044
Annualized benefits (weekday only) minus annualized cost		$416,571
Annualized benefits (full week) minus annualized cost		$516,501
Benefit/cost ratio weekday only		2.4
Benefit/cost ratio full week		2.8

Since AATA currently has implemented AVL on its entire fleet, the system also was asked to assist with a SCRITS analysis of this particular technology. The user inputs and resulting calculated values for the pre- and post-deployment conditions for the automatic vehicle location and information worksheet are shown in Tables 3-15 and 3-16, respectively. Data for average weekday daily boardings (15,000) and average daily boardings for a full week (12,000) were replicated from the electronic fare collection system analysis presented previously.

AATA staff estimated the total cost (including installation) of its AVL system to be about $2,100,000. The anticipated useful service life of the equipment was indicated to be 8 years. An annual operating/ maintenance cost for the system of $203,000 was provided; however, like the case for its electronic fare system, a value of zero dollars was used for annual labor cost savings since AATA staff believe that the AVL implementation also may have resulted in additional labor costs (though, as for the other technology, this potential increase could not be estimated).

Table 3-15
SCRITS Worksheet: Pre-Implementation Analysis of AATA's Automatic Vehicle Location

	User Input	Calculated Value
TRAFFIC AND TRAVEL (USER BENEFITS ONLY)		
Current average wait time per passenger (min.)	5	
Average wait time with AVL system (min.)	2	
Average number of weekday daily boardings	15,000	
Average number of daily boardings, full week	12,000	
Percent of passengers that use the information	40%	
Hours of time saved per weekday		300
Hours of time saved per average day, full week		240
Hours of time saved per year, weekdays only		76,800
Hours of time saved per year, total		87,600
COSTS AND BENEFITS		
Annual value of time savings, weekdays only		$1,014,528
Annual value of time savings, full week		$1,157,196
Installation cost	$2,100,000	
Service life (years)	8	
Annual operating/maintenance cost	$203,000	
Annual savings in agency labor cost	$0	
Annualization factor		0.167
Total annualized cost		$350,700
Annualized benefits (weekday only) minus annualized cost		$663,828
Annualized benefits (full week) minus annualized cost		$806,496
Benefit/cost ratio weekday only		2.9
Benefit/cost ratio full week		3.3

Table 3-16
SCRITS Worksheet: Post-Implementation Analysis of AATA's Automatic Vehicle Location

	User Input	Calculated Value
TRAFFIC AND TRAVEL (USER BENEFITS ONLY)		
Current average wait time per passenger (min.)	5	
Average wait time with AVL system (min.)	2	
Average number of weekday daily boardings	15,000	
Average number of daily boardings, full week	12,000	
Percent of passengers that use the information	40%	
Hours of time saved per weekday		300
Hours of time saved per average day, full week		240
Hours of time saved per year, weekdays only		76,800
Hours of time saved per year, total		87,600
COSTS AND BENEFITS		
Annual value of time savings, weekdays only		$1,014,528
Annual value of time savings, full week		$1,157,196
Installation cost	$2,100,000	
Service life (years)	8	
Annual operating/maintenance cost	$203,000	
Annual savings in agency labor cost	$0	
Annualization factor		0.167
Total annualized cost		$350,700
Annualized benefits (weekday only) minus annualized cost		$663,828
Annualized benefits (full week) minus annualized cost		$806,496
Benefit/cost ratio weekday only		2.9
Benefit/cost ratio full week		3.3

As noted before in the LYNX AVL analysis, there are three other user inputs needed for the AVL analysis worksheet: current average wait time per passenger, average wait time per passenger with the AVL system, and percent of passengers utilizing real-time information from the AVL system. For the pre-deployment case, AATA staff estimated current average wait time to be about five minutes. By using the AVL-derived real-time information at AATA's transfer stations (the only stops currently providing this information), it was expected that passengers would wait only two minutes, on average. Additionally, AATA staff originally estimated that about 40 percent of its patrons would make use of the available information.

Next, the post-deployment case was discussed with AATA staff. Interestingly, it is staff's belief that the actual input values for this technology are identical to those that were estimated for the pre-deployment case. That is, average wait time after deployment of the AVL system is about two minutes for those utilizing the AVL-derived information and approximately 40 percent of AATA's passengers are making use of the information.

As shown in Tables 3-15 and 3-16, then, the results for the pre-and post-implementation analyses are identical. AATA's user inputs result in an annual value of time savings for its passengers of nearly $1.2 million (about $1.0 million if only weekday service is included). The benefit/cost ratio for this technology for a full week is 3.3 (2.9 for weekdays only). It should be noted, however, that staff believe that greater user benefits could be achieved if real-time information was available through more outlets (e.g., telephone, television, Internet, all bus stops, etc.), instead of just at the system's transfer stations.

Comparison of Results

Although changes did occur between the pre-and post-deployment results for each of the systems analyzed using the three transit-related SCRITS worksheets, for the most part, it is evident in the previous analyses that benefits (in terms of user time savings) have resulted from the various implementations. As presented in Table 3-17, time savings (13 percent) and benefit/cost ratios (6 percent) have increased between expected and achieved results, on average. Based on the post-deployment results, average annual time savings related to the deployment of electronic fare collection at the five systems totals nearly $1.5 million, and the average benefit/cost ratio achieved for this technology is 6.4.

Table 3-17
SCRITS Electronic Fare Collection Worksheet Analysis: Comparison of System Results[1]

Transit System	Annual Value of Time Savings			Benefit/Cost Ratio		
	Pre	Post	% Chg	Pre	Post	% Chg
PSTA	$2,910,784	$2,716,732	-7%	7.4	6.9	-7%
HART	$304,705	$1,618,087	431%	1.4	7.2	414%
LYNX	$3,287,655	$2,136,976	-35%	20.6	13.4	-35%
SCAT	$52,019	$131,608 [2]	153%	0.7	1.7 [2]	143%
AATA	$0	$810,545 [2]	n/a	0.0	2.8 [2]	n/a
Average	$1,311,033	$1,482,790	13%	6.0	6.4	6%

[1] All of the information presented in this table is for the "full week" case.
[2] Since SCAT and AATA have not implemented the use of electronic fare media yet, their post-implementation results have been estimated using mean values based on the post-deployment experiences of the other three transit systems for average boarding time with electronic fare and the percent of electronic fare use.

From the data presented in Table 3-17, it also is evident that PSTA's electronic fare collection implementation has resulted in the largest annual value of time savings at more than $2.7 million, based on post-deployment user inputs. The other systems' time savings values range from approximately $132,000 to $2.1 million. Conversely, the greatest benefit-to-cost ratio has been achieved by LYNX. This system's analysis indicated that its electronic fare collection system deployment resulted in a benefit/cost ratio of 13.4. The other systems' benefit/cost ratios range from 1.7 to 7.2.

In Table 3-18, a similar comparison is made for the two systems, LYNX and AATA, that currently have AVL technology in place. Overall, it is apparent that the average user time savings resulting from these agencies' AVL systems decreased 58 percent between the expected and achieved figures. Similarly, the average benefit-to-cost ratio decreased 86 percent. These declines are primarily attributable to LYNX staff's contention that the LYMMO AVL system has not produced any real time savings for its users because of LYMMO's shorter-than-originally-planned headways. However, despite these declines, the average annual time savings related to the deployment of AVL still is approximately $579,000, and the average benefit/cost ratio is 1.7. Given the particular operating characteristics of LYMMO (i.e., frequent downtown circulator), and the fact that AATA's AVL system has been implemented on its entire fleet, it is anticipated that other systemwide AVL implementations would generate benefits results more like those experienced at AATA.

Table 3-18
SCRITS Automatic Vehicle Location Worksheet Analysis: Comparison of System Results[1]

Transit System	Annual Value of Time Savings			Benefit/Cost Ratio		
	Pre	Post	% Chg	Pre	Post	% Chg
LYNX	$1,611,256	$0	-100%	21.1	0.0	-100%
AATA	$1,157,196	$1,157,196	0%	3.3	3.3	0%
Average	$1,384,226	$578,598	-58%	12.2	1.7	-86%

[1] All of the information presented in this table is for the "full week" case.

Finally, Table 3-19 examines the comparison of the pre- and post-implementation results for the three transit-related technologies included in the SCRITS analysis tool. The data in the table for the electronic fare collection and AVL technologies reflect system averages compiled previously in Tables 3-17 and 3-18. The bus priority data is representative of LYNX's LYMMO circulator, since it is the only one of the five transit systems analyzed herein that has implemented some level of bus prioritization.

Table 3-19
SCRITS Worksheet Analysis: Comparison of Technologies [1]

Transit System	Annual Value of Time Savings			Benefit/Cost Ratio		
	Pre	Post	% Chg	Pre	Post	% Chg
Electronic Fare Collection	$1,311,033	$1,482,790	13%	6.0	6.4	7%
AVL	$1,384,226	$578,598	-58%	12.2	1.7	-86%
Bus Priority	$452,565	$179,691	-60%	6.4	2.4	-63%
Average	$1,049,275	$747,026	-29%	8.2	3.5	-57%

[1] All of the information presented in this table is for the "full week" case and system averages are used for the electronic fare collection and AVL technologies.

The information in Table 3-19 indicates that the electronic fare collection technology resulted in the highest actual annual value of time savings, $1,482,790, based on the user inputs provided by the transit systems, while bus priority had the lowest user time savings ($179,691). Similarly, the electronic fare collection technology achieved the highest average benefit/cost ratio at 6.4, while AVL had the lowest, 1.7.

It may be the case that electronic fare collection achieved higher time savings than either AVL or bus priority because of the respective nature of the technologies. With electronic fare media, all bus passengers ultimately benefit because of the faster overall boarding process and the decrease in boarding time as a percent of total bus travel time. For AVL, only those passengers making use of the AVL's real-time information experience any time savings (and then, only for wait time, which does not impact bus travel time such that ancillary benefits can accrue to those passengers not utilizing the real-time information). In addition, for bus prioritization, any passenger time savings that are achieved must be offset by the negative time impact on traffic in or crossing the bus corridor.

However, it also is likely that this result has been impacted by the case study systems' respective levels of experience with the three technologies. Clearly, these systems have had the greatest level of experience with the electronic fare collection technology to date. Three of the systems have had electronic registering fareboxes and electronic fare media in use for several years and, based on discussions with staff at these systems, there seems to be a better understanding of this technology and its benefits (potential and/or realized). This comprehension was reflected in the collection of user input data, which was easier and more straightforward for the electronic fare collection worksheet than for either the AVL or bus priority worksheets, where it seemed that much more estimation was necessary.

Perhaps with greater experience and a better understanding of the AVL and bus priority technologies, improved evaluation results will occur.

Assessment of the SCRITS Tool & Analysis Process

Not only will greater experience and understanding of the three technologies analyzed herein result in an improved evaluation process, but it is apparent from this effort that increased comprehension of the SCRITS tool, itself, also will be necessary. One of the primary reasons for selecting the SCRITS tool to conduct the analyses described previously is that it would be simpler to use than IDAS and would require a much lower level of user input. Unfortunately, in working with the case study transit systems to complete the worksheet analyses it was determined that SCRITS still is relatively difficult to use because of its required inputs.

While working with the case study systems on their respective SCRITS analyses, it was found that the necessary user inputs for the various worksheets fell into three categories: information that is known or can be located easily, information that exists but is difficult (or, in some cases, almost impossible) to find, and information that does not exist and/or is not collected and must be estimated. Using the electronic fare collection worksheet as an example, the systems did not have any problems providing data on ridership, average bus speed, or average passenger trip length. System staff assisting with each analysis knew this information or could easily calculate it from NTD statistics or system-developed planning databases. Then there was the information that posed more problems to acquire, such as the cost and service life data for the electronic fare collection system. In each case, the original planning and/or operations contacts had to recruit assistance from individuals in other departments, such as finance or maintenance, to find this information. In some instances, the information was extremely difficult to locate because people who were responsible for it at the time of implementation were no longer at the system and support documentation was lacking or unavailable. In other cases, such as for annual operating/maintenance cost and annual labor cost savings, it was discovered that the information was not even collected or maintained on a regular basis. For many of these inputs, then, it was necessary for staff to make educated estimates based on the information that was available.

Other user inputs on the electronic fare collection worksheet that perplexed system staff included average percent of bus travel time devoted to boarding and average passenger boarding times with conventional and electronic fare. This also is information that is not collected or maintained in any format. According to most of the system contacts, these and other inputs on the three SCRITS worksheets are not likely to be collected because they are not necessary for the day-to-day operation of a transit system. It was stressed several times that a transit agency is in the business of getting buses on the road to transport people, and not collecting data that they do not believe serves that purpose. As a result, these type of variables needed to be estimated by system staff in order to complete the analyses.

Unfortunately, this need for estimation resulted in another issue that impacted the analyses: perception versus reality. As exemplified in the HART case study, it is the case that transit staff perception of boarding times does not match what actually occurs in a real-world situation. The systems' inputs for average boarding time for passengers using electronic fare ranged from three to five seconds. However, the brief supplementary survey analysis that HART staff conducted on boarding times found that the average boarding time for a person using an electronic fare card is more than seven seconds. A similar result was found when comparing HART's estimated and survey-based boarding times for those passengers using conventional fares. These findings suggest that the SCRITS electronic fare collection analysis would have had different annual time savings and benefit/cost ratio values had each system conducted a similar analysis that would have produced more representative boarding times. It is probable that this same issue impacted other user inputs on the three worksheets, as well, such as percent of passengers using AVL-based real-time information, average wait time per passenger (with or with out an AVL system), percentage of bus travel time attributable to signal delay, and percentage of traffic that incurs pre-emption delay, among others.

Further exacerbating the estimation problem is lack of experience with a given technology (i.e., those systems that truly are in a pre-implementation phase). In working with AATA and SCAT, which have both implemented electronic fareboxes but are not utilizing electronic fare media yet, it was found that estimating necessary user inputs (like average boarding times and percent of passengers with electronic fare) was more difficult for these systems than for the others that already had experience with the technology. Since SCRITS is touted as a pre-planning analysis tool, this issue is particularly perplexing. In both of these cases, system staff had to rely on their knowledge of the experiences at other transit agencies and/or information from vendors, product documentation, etc., to help in developing their estimates for particular user inputs.

Besides these issues with data collection/estimation to satisfy the SCRITS user input requirements, staff at the case study systems also offered their opinions about the overall SCRITS process and its use as an assessment tool, as well. Primarily, there are two major concerns about this tool and/or the type of comparative analysis that it engenders. First, the systems believe that the SCRITS output, while potentially useful for certain purposes, is not as valuable or useful as it could be because it does not estimate agency benefits. While system staff see the benefit of being able to explain to their respective oversight boards what benefits might accrue to transit passengers if a particular technology were to be implemented, it is their informed expectation that, invariably, these boards would want to know the ultimate benefit to the agency. Without such information, in their opinion, the tool loses much of its value in being able to help sell APTS deployment.

The second concern involves the comparability of SCRITS results across systems. One of the benefits of such a tool is the relative standardization that it can provide to the evaluation of APTS technologies. If a number of systems are compared using the SCRITS tool for a particular technology, then it is the case that all of the systems will utilize the same set of input variables and have their respective benefits results calculated in the same manner. However, as indicated in the previous discussion on perception versus reality, it is not the case that the process of systems estimating various of their respective user inputs will promote the assurance of "apples to apples" comparability. Unless strict guidelines are established for the collection and/or development of each user input, it will not be possible to conduct comparable analyses across systems. This particular issue is the reason why FTA has established such rigorous reporting guidelines for its National Transit Database – to ensure that the resulting information is comparable across systems. However, it is still argued by many users of this particular database that the information never truly will be comparable because of the host of system-level data collection and reporting idiosyncrasies that occur each year that serve to undermine the original intent of FTA's National Transit Database. For this reason, it also is unlikely that strict procedures for compiling SCRITS user inputs will put to rest completely the transit systems' concerns regarding "comparability across agencies," especially since it appears that, for the most part, all transit agencies believe that they are inherently different from one another and cannot be compared anyway. As one staff member indicated during one of the phone interviews conducted for this evaluation, "Too many things are unique to each property to compress everything into a few formulas and have it be applicable across the board."

Nevertheless, it must not be discounted that, despite these concerns, staff at the case study systems indicated that they appreciated the SCRITS exercise because it made them think about issues and information related to APTS and the technologies in use at their respective systems that they had not considered before. Because of the nature of their jobs, some of these individuals intimated that their current duties almost require them to operate with blinders on most of the time in order to get everything done for which they are responsible. Being able to think about the SCRITS tool and its inputs, however, enabled them to step back from the everyday issues and tasks of their jobs and get involved in more "big picture" thinking. The opportunity to do this was seen as an important ancillary benefit.

RECOMMENDATIONS FOR PERFORMANCE MONITORING MEASURES

As stated previously in this chapter's introduction, it is extremely important for transit systems considering or actually deploying APTS to assess its potential benefits before implementation and to monitor its performance after deployment. These type of analyses are beneficial because they can highlight efficiencies, help justify costs, and provide an agency with important support information as it shares its APTS experiences with others. The previous sections have detailed benefits analyses for various technology deployments at five different case study transit systems. These analyses have utilized the SCRITS pre-planning analysis tool to derive estimates for annual passenger time savings benefits and benefit/cost ratios for electronic fare collection, automatic vehicle location, and bus priority technologies. In this section, the concept of performance criteria and monitoring is introduced.

The development of performance measurements for APTS technologies is critical because these measures enable an agency to assess how a particular technology is functioning and whether pre-determined goals have been met by its deployment. Important to the process of performance monitoring are *defining the goals and objectives* of the transit system and *establishing the measures* of effectiveness and efficiency related to those goals and objectives. While the goals and objectives of each transit agency may vary, this section identifies those that are most common and provides examples of how post-deployment measures of effectiveness can be determined.

Defining the Goals and Objectives

Prior to deploying APTS technologies, most transit systems have preset goals that typically are described in transit plans or other documents. These goals usually reflect the interests of all concerned stakeholders, such as transit users, operators, agency administrators, local governmental entities, and private partners. Furthermore, the National ITS Architecture also has identified goals that pertain to transit ITS and it has had increasing influence over the development of regional, state, and local ITS initiatives, such as FDOT's ITS Strategic Plan. The result is a set of goals which appear standard throughout the country. These goals are[33]:

- Increase the operational efficiency and capacity of the system.
- Enhance the personal mobility, convenience, and comfort for users of the system.
- Improve the safety of the system.

[33] *ITS Deployment Guidance for Transit Systems, Technical Edition*, U.S. Department of Transportation, Federal Highway Administration, April 1997.

- Reduce energy consumption and environmental costs.
- Enhance present and future economic productivity of individuals, organizations, and the community.
- Create an environment in which the development and deployment of ITS can flourish.

At some point, representatives of each of the identified groups of stakeholders participate in the shaping of the goals and determining which objectives will best help to achieve those goals. Some of the more common objectives of transit agencies are to increase ridership, improve on-time performance, reduce travel times, enhance traveler security, and increase intermodal transportation opportunities. It is also possible that the chosen objectives may vary depending on transit system type (i.e., demand-response versus fixed-route). Once the objectives have been identified, typically, those persons more involved with the management and operation of the transit system develop the specific methods for measuring the effectiveness of the tools used to achieve the objectives – in this case, the APTS applications.

Establishing the Measures

Since APTS deployment is *relatively* new, there are few definitive guides that identify standard measures of effectiveness and efficiency for specific technologies. Fortunately, though, transit personnel have had extensive experience monitoring the performance of transit service, itself, so the concept of performance measures is not really foreign. For example, a typical route analysis will examine how a route is performing in terms of passenger trips per revenue hour of service, operating expense per hour, and farebox recovery (i.e., the ratio of passenger fare revenue collected on the route to the cost of operating it), among other measures.

For purposes of evaluating APTS, the primary categories of measures are related to user convenience and acceptance, transit system effectiveness, and transit system efficiency. Within these categories are specific measures that allow the evaluation of an APTS technology's performance. The *ITS Deployment Guidance for Transit Systems, Technical Edition,* identifies suggested "measures of effectiveness," or MOEs, that can be used for the purpose of performance evaluation. These MOEs should represent the concerns of the stakeholders and usually measure safety, cost, capacity, satisfaction, and delays in various ways. Examples of measures identified in the publication are:

- number of transit riders per year
- transit vehicle occupancy
- travel times (minutes)
- number of accidents

- total annual transit miles
- transit revenue

These and other measures are established with specific system goals and objectives in mind. At the onset, a transit agency should identify what the goals and objectives of its system are and what it hopes to accomplish through the deployment of APTS technologies. The document, *Advanced Public Transportation Systems: Evaluation Guidelines*, provides an example of a matrix that demonstrates the relationship between common system objectives and categories of measures.[34] Table 1 presents a modified version of the matrix from that publication using the most common objectives of transit agencies.

APTS Applications

While Table 1 identifies those common objectives and applicable measures of effectiveness, the following section briefly describes which APTS applications can assist in achieving the objectives and how they might be used in determining the measurements of effectiveness.

According to the *Economic and Policy Considerations of Advanced Public Transportation Systems (APTS): Assessing the Economic Feasibility of APTS*, APTS applications can be categorized as Smart Traveler Technologies, Smart Intermodal Systems, and Smart Vehicle Technologies.[35] Smart Traveler Technologies are those that allow the users to have access to reliable, real-time information either when making plans for using public transportation or while using it. The main purpose of Smart Traveler applications is to make public transportation more convenient for users, which can have a direct impact on the growth of ridership and user satisfaction. Examples of Smart Traveler applications include advanced/integrated fare payment media, information kiosks, on-bus annunciators, passenger information displays, and computerized passenger information systems.

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[34] Casey, Robert F. and John Collura, *Advanced Public Transportation Systems: Evaluation Guidelines*, prepared by the Volpe National Transportation Systems Center for the Office of Technical Assistance, Federal Transit Administration, January 1994.

[35] Ball, William. *Economic and Policy Considerations of Advanced Public Transportation Systems (APTS): Assessing the Economic Feasibility of APTS*, prepared by the National Urban Transit Institute at the Center for Urban Transportation Research, October 1994.

Table 3-20
Examples of APTS Program Objectives and Performance Measures

Category of Measure	**Objectives**							
	Reduce Travel Time/Improve On-Time Performance	*Improve On-Board Safety & Security*	*Increase ridership*	*Increase Fare Payment Options*	*Improve Availability of Information*	*Enhance Opportunities for Customer Feedback*	*Reduce Transit System Costs*	*Increase Intermodal Capabilities & Opportunities*
Transit System Effectiveness	• % on-time • headway • time by car • transit travel time	• accident rate • incident rate • crime incident rate • farebox shortages	• increase in service area	• # of payment options • queue lengths	• accuracy of info • type of information relayed	• # of opportunities for feedback • type of feedback opportunities	• # shared trips (demand-response)	• reduction in SOV trips • # of multi-mode trips
Transit System Efficiency	• boarding or alighting time	• changes in vehicle down-time • changes in time system is monitored by camera, staff, or other methods	• # trips per capita • average vehicle occupancy	• # using each option	• # of info outlets • # users of each outlet • # and type of inquiries	• # of responses received	• change in cost per trip • change in operating costs • change in maintenance costs	• travelers per mode • change in roadway LOS
Customer Convenience and Satisfaction	• perceptions regarding travel time changes	• rider perception regarding safety	perceptions regarding popularity of transit system (i.e., is it used?, are buses full?)	• rider perception on convenience • # users of new options	• perceptions regarding customer info services • most popular info outlet	• perceptions regarding ability to provide feedback	• perceptions regarding level of service	• perceptions regarding ease of traveling between modes

Smart Intermodal Systems can help providers of public transportation offer more intermodal opportunities to users by ensuring that the coordination and integration of services are convenient, user-friendly, and efficient. Such integration is achieved when APTS applications simplify aspects of intermodal service. For example, Smart Intermodal applications that offer uniform fare media capabilities enable travelers to use a single payment technique for varying transportation alternatives. Another example of Smart Intermodal Systems are computerized passenger information systems that allow travelers to pre-plan an intermodal trip through use of a telephone or computer.

The third category of APTS applications is Smart Vehicle Technologies. The primary purpose of advanced vehicle technology is to provide more efficient and effective fleet planning, scheduling, and operations through applications such as AVL systems, automatic passenger counters (APCs), computerized dispatching/scheduling systems, advanced communications systems, and vehicle component monitoring systems. Many Smart Traveler and Smart Intermodal applications are not as effective without the real-time data provided by the use of Smart Vehicle Technologies. Consequently, the integration of applications from all categories of APTS technologies is important to the successful development and deployment of ITS. Table 2 lists some of the more common APTS applications and identifies those objectives that they may be instrumental in achieving.

Based on the documented APTS experiences around the country to date, it would appear that ITS technologies can be quite valuable to a transit agency in the determination of its system's performance effectiveness. The technologies not only can have an impact on the system's level of effectiveness, itself, but they also have a role in the more accurate collection of the data that ultimately is used to measure performance effectiveness. Effectiveness, as well as efficiency and the level of convenience of the system to its users, are categories of measures that typically allow a transit system to determine whether the objectives of the agency (and other related stakeholders) are being met.

Table 3-21
APTS Applications and Measures Matrix

Objective	APTS Applications								
	Info Kiosks & Passenger Info Displays	Advanced Fare Payment Media	Automated Vehicle Locators	Automatic Passenger Counters	Computerized Dispatching/ Scheduling	Advanced Communications Systems	On-Board Bus Annunciators	Computerized Passenger Information Systems	Vehicle Component Monitoring Systems
Reduce Travel Time/Improve On-Time Performance	●	●	●	●	●	●	●	●	●
Improve On-Board Safety/Security		●	●		●	●	●		●
Increase Ridership	●	●	●		●	●	●	●	●
Increase Fare Payment Options	●	●						●	
Improve Availability of Information	●		●		●	●	●	●	
Enhance Opportunities for Customer Feedback	●							●	
Reduce Transit System Costs	●	●	●	●	●	●	●	●	●
Increase Intermodal Capabilities	●	●	●	●	●	●	●	●	●

SUMMARY OF CHAPTER THREE

This third chapter for the Inventory and Analysis of Advanced Public Transportation Systems in Florida project has provided an assessment of the annual time savings benefits that five case study transit systems have accrued for their respective passengers through the implementation of one or more of three different APTS technologies: electronic fare collection, AVL, and bus priority. The SCRITS spreadsheet-based, pre-planning analysis tool was utilized to conduct the analysis of each system. These analyses examined pre- and post-deployment conditions for each technology being used, or soon to be utilized, by each system.

In addition, the topic of post-deployment performance measurement and monitoring also was introduced. The development of performance measurements for APTS technologies is extremely important because such measures enable an agency to assess how a particular technology is functioning and whether established system goals and objectives have been met by its deployment. This discussion also provided some examples of, and general recommendations for, performance measures that are applicable to the more common goals and objectives and identified specific APTS applications that may be used to achieve the objectives.

From the overall benefits analysis process, it was learned that, despite the relative simplicity of SCRITS compared to other similar analysis tools, it is still somewhat difficult to understand – especially some of the required user inputs for each of its technology worksheets. Other drawbacks of this analysis tool are that the number of APTS-specific technologies that it is designed to evaluate is extremely limited and it can only estimate the time savings benefits that accrue to a transit agency's passengers, and not any of the potential benefits that might be realized by the agency, itself. Nevertheless, the SCRITS tool is readily available for free and is a decided step in the right direction of establishing a standardized benefits analysis process that is easily transferable between systems, regardless of size or operating environment/characteristics, and produces results that can be understood and compared across technologies and/or agencies.

The individual system analyses also provided interesting insights, as well. For the most part, the analyses found that the majority of the APTS deployments at the case study systems have indeed benefitted passengers of those agencies in terms of annual time savings. The resulting benefit-to-cost ratios also have been positive. Unfortunately, the analyses also helped identify a number of issues at the systems related to data collection and information availability, the estimation of user inputs for the SCRITS analysis, lack of experience with APTS technologies, and concern about comparability of analysis results across systems.

Working with the case study systems on their respective SCRITS analyses, it was determined that information for some of the necessary user inputs was extremely difficult to locate and, in some instances, did not even exist or was not collected. Issues contributing to this problem included information being collected/compiled by different persons and/or departments with no real process for centralizing files or data, person(s) originally responsible for information at the time of implementation leaving the agency without passing on any support documentation or data, and staff not having the time and/or wherewithal to collect information that does not directly serve the transit agency's main purpose of getting buses on the road to transport people. This issue of missing or incomplete information resulted in many of the case study systems having to make educated estimates for several of the inputs based on whatever information they did have available.

The need to estimate certain variables resulted in another issue that impacted the analyses: perception versus reality. As exemplified in the HART case study related to average boarding times, it is the case that transit staff perception of particular passenger and/or system characteristics does not match necessarily what actually occurs in a real-world situation. Because of the variability inherent in the estimation process, then, this particular issue can have a significant impact on the desired goal of standardized evaluation processes. Without specific guidance on the calculation or estimation of each user input, true comparability of results across systems/technologies may not be possible.

Further exacerbating this problem with estimation is the lack of experience with APTS technology at many transit systems, especially those that have not had any deployment opportunities. In working with the two case study systems that did not have specific experience with electronic fare media, it was noted that the estimation process for several user inputs (e.g., average boarding time for passenger with electronic fare, percent of passengers with electronic fare) was much more difficult than for those already experienced with electronic fare collection. Since SCRITS is touted as a pre-planning analysis tool, this issue is particularly perplexing.

Finally, in discussing their thoughts about SCRITS and the analysis process, staff at the case study systems expressed their concern over the possibility of comparing the benefits assessment results across systems. Because of the estimation and perception issues, as well as the apparently widespread belief among transit agencies that they are inherently different from one another and cannot be compared in any meaningful fashion, it is questioned whether true "apples to apples" comparability will be possible.

Despite these issues and concerns, however, based on the research experience with the five case study transit systems involved in this analysis, it would appear that personnel at the systems are aware of the importance of benefits assessment and measuring the performance of APTS technologies. They understand the need for establishing verifiable benefits related to APTS deployment so that this information can be used to help sell their systems' potential future APTS applications to their boards, local officials, and stakeholders. Being able to demonstrate positive performance of existing technologies will help in this regard, as well. In addition, the transit industry, itself, will be well served by the additional APTS evaluation information that will be available to be shared.

Lastly, it is important to note a final positive outcome from the analysis process detailed herein: the opportunity for transit planning and operation staff to pull themselves out of the specific detail focus of their jobs and get involved in more "big picture" thinking related to the implementation of APTS. At any transit agency, it is these individuals that may understand best what applications may help improve aspects of service for passengers or system effectiveness/efficiency. They are also in the best position to collect and compile the necessary data for assessing benefits and monitoring technology performance. As such, it will be important for transit agencies to facilitate their involvement in most, if not all, aspects of the development and deployment of APTS in order to help ensure success and appropriate assessment.

Appendix A

Initial APTS Inventory Questionnaire

Advanced Public Transportation Systems
Inventory Questionnaire

AGENCY NAME:					
RESPONDER NAME:					
TITLE:					
ADDRESS:					
TEL:					
FAX:					
E-MAIL:					
TOTAL NUMBER OF VEHICLES IN OPERATION:					
MODES OPERATED:	Fixed Route:		Demand Responsive:		
CAPACITY:	Standing:		Seating:		
MANUFACTURERS:					
ADA ACCESS?	Yes:		No:		Wheelchair Capacity:

If the answer to the numbered question is "yes" please proceed to part (a) and/or (b) of that question, otherwise, continue on to the next question.

I FLEET MANAGEMENT

Automated Vehicle Location Systems

1. Does your agency currently have or intend to have an automated vehicle location system for its vehicles?

Yes	No

(a)

Technology	
GPS	
Signpost/Odometer	
Dead-Reckoning	
Loran-C	
Others (Please Specify)	

(b)

Status	
Planning	
Testing	
Implementation/Testing	
Implementation	
Fully Operational	

Number and type of vehicles equipped:

Automatic Passenger Counter

2. Does your agency currently have or intend to have automatic passenger counters on its vehicles?

Yes	No

(a)

Technology	
Infrared Beams	
Treadle Mats	
Infrared Optic Sensors	
Ultrasonic Frequency Sensors	
Others (Please Specify)	

(b)

Status	
Planning	
Testing	
Implementation/Testing	
Implementation	
Fully Operational	

Number and type of vehicles equipped:

Vehicle Component Monitoring System

3. Does your agency currently have or intend to have a vehicle component monitoring system for its vehicles?

Yes	No

(a)

Condition	
High Engine Temperature	
Low Oil Pressure	
Others (Please Specify)	

(b)

Status	
Planning	
Testing	
Implementation/Testing	
Implementation	
Fully Operational	

Number and type of vehicles equipped:

Automated Operations Software

4. Does your agency currently have or intend to have software that integrates any of the following transit operations functions?

Yes	No

(a)

Activities	
Computer Aided Dispatch	
Vehicle Performance	
Loading	
Driver Performance	
Schedule Monitoring	
Passenger Statistics	
System-wide Statistics	
Others (Please Specify)	

(b)

Status	
Planning	
Testing	
Implementation/Testing	
Implementation	
Fully Operational	

On Board Safety Systems

5. Does your agency currently have or intend to have any on board safety features in its vehicles?

Yes	No

(a)

Features	
Silent Alarms	
Passenger Clearance Sensors	
Others (Please Specify)	

(b)

Status	
Planning	
Testing	
Implementation/Testing	
Implementation	
Fully Operational	

Number and type of vehicles equipped:

II TRAVELER INFORMATION

Trip Planning Information

1. Does your agency provide or intend to provide trip planning information for your passengers?

Yes	No

(a)

Location	
Touch-tone Telephones	
Internet	
Fax Machines	
Kiosks	
Others (Please Specify)	

(b)

Status	
Planning	
Testing	
Implementation/Testing	
Implementation	
Fully Operational	

Trip Planning Information (Single Mode and/or Multimodal)

2. Does your agency provide or intend to provide trip planning information for single mode and/or multimodal information for your passengers?

Yes	No

(a)

Information	
Schedules, Fares	
System Disruption	
Carpooling and Parking	
Incidents and/or Weather	
Routes, Stop Locations	
Ride-matching Registration	
Others (Please Specify)	

(b)

Status	
Planning	
Testing	
Implementation/Testing	
Implementation	
Fully Operational	

In-terminal Information Systems

3. Does your agency provide or intend to provide in-terminal information for your passengers?

Yes	No

(a)

Technology	
Electronic Signs	
Kiosks	
Television Monitors	
Annunciators	
Others (Please Specify)	

(b)

Status	
Planning	
Testing	
Implementation/Testing	
Implementation	
Fully Operational	

In-vehicle Information Systems

4. Does your agency provide or intend to provide in-vehicle information for your passengers?

Yes	No

(a)

Technology	
Electronic Signs	
Television Monitors	
Annunciators	
Others (Please Specify)	

(b)

Status	
Planning	
Testing	
Implementation/Testing	
Implementation	
Fully Operational	

Number and type of vehicles equipped:

III ELECTRONIC FARE PAYMENT

Automated Fare Payment

1. Does your agency currently have or intend to have automated fare payment system on its vehicles?

Yes	No

(a)

Technology	
Magnetic Strip	
Smart Card	
Credit Card	
Proximity Cards	
Others (Please Specify)	

(b)

Status	
Planning	
Testing	
Implementation/Testing	
Implementation	
Fully Operational	

Number and type of vehicles equipped:

Multi-carrier Reservation and Billing Systems

2. Does your agency currently have or intend to have multi-carrier trip reservation and integrated billing systems?

Yes	No

(a)

Technology	
Between Different Modes	
With ATM and/or Credit Cards	
Between Different Providers	
Others (Please Specify)	

(b)

Status	
Planning	
Testing	
Implementation/Testing	
Implementation	
Fully Operational	

Number and type of vehicles equipped:

IV TRANSPORTATION DEMAND MANAGEMENT TECHNOLOGIES

Advanced Communications

1. Does your agency currently have or intend to have advanced communication system for its vehicles?

Yes	No

(a)

Technology	
Analog Land Mobile	
Digital	
Trunked + Digital	
Other + Digital	
Others (Please Specify)	

(b)

Status	
Planning	
Testing	
Implementation/Testing	
Implementation	
Fully Operational	

Number and type of vehicles equipped:

Automated Service Coordination

2. Does your agency currently have or intend to have any technologies to integrate and coordinate transportation services in your region? (A "one-stop shopping" for the traveler in your region).

Yes	No

(a)

Technology	
Scheduling	
Routing	
Information Systems	
Billing	
Others (Please Specify)	

(b)

Status	
Planning	
Testing	
Implementation/Testing	
Implementation	
Fully Operational	

Transportation Management Center (TMC)

3. Is there a TMC in your region? Are you part or intend to be part of this TMC?

Yes	No

What are the technologies that are used to integrate and distribute transit information from the TMC?

(a)

Technology	
Pagers, Telephone	
Electronic Signs On Board	
Information Kiosks	
Cable Television	
Others (Please Specify)	

(b)

Status	
Planning	
Testing	
Implementation/Testing	
Implementation	
Fully Operational	

Signal Preemption

4. Does your agency currently have or intend to have traffic signal priority on your routes? If yes, how many intersections?

Yes	No

(a)

Status	
Planning	
Testing	
Implementation/Testing	
Implementation	
Fully Operational	

Dynamic Ridesharing

5. Does your agency have or intend to have a central database or operation center for an organized dynamic ridesharing program? (This form of ridesharing is used to obtain a ride for a single, one way or round trip rather than for trips made on a regular basis).

Yes	No

(a)

Status	
Planning	
Testing	
Implementation/Testing	
Implementation	
Fully Operational	

High Occupancy Vehicle Lane Access

6. Does your agency currently have or intend to have high occupancy vehicle lane access for its vehicles? (This is a device/transponder on the vehicle, which gives access to high occupancy vehicle only lanes).

Yes	*No*

(a)

Status	
Planning	
Testing	
Implementation/Testing	
Implementation	
Fully Operational	

Number and type of vehicles equipped:

V PARATRANSIT PROVIDERS

Automated Paratransit

1. Does your agency currently have or intend to have an automated paratransit system?

Yes	*No*

(a)

Activities	
Computer Aided Dispatch	
Scheduling	
Others (Please Specify)	

(b)

Status	
Planning	
Testing	
Implementation/Testing	
Implementation	
Fully Operational	

Number and type of vehicles equipped:

VI "OTHER"

1. Does your agency currently have or intend to have any other type of technology for APTS application, which we have over-looked to mention in the above questions.

Yes	*No*

What type of technology and for what application?

Number and type of vehicles equipped:

If you have questions please feel free to contact Shireen Chada at Center for Urban Transportation Research (CUTR). Please send the inventory questionnaire back to the address given below no later than March 24, 2000.

Tel:	**(813) 974 5307**
Email:	chada@cutr.eng.usf.edu**.**
Fax:	**(813) 974 5168**
Address:	**Attn: Shireen Chada** **Center for Urban Transportation Research** **University of South Florida** **4202 E Fowler Avenue, CUT 100** **Tampa, FL 33620-5375**

APPENDIX B
Follow-Up APTS Inventory Questionnaire

FOLLOW UP APTS INVENTORY QUESTIONNAIRE

It is not necessary for you to answer all questions. We would like for you to answer all questions, but if you do not have an opinion on any particular question just put "No Opinion."

For "Staff Opinions", please answer the questions that apply to your transit agency only.

Agency Name:	
Person Interviewed:	
Telephone No.:	
Email Address:	

GENERAL

1. *Did you address APTS in your Transit Development Plans?*
2. *How much consideration has been given to ITS-Transit in the overall operational scheme?*
3. *How important is it to include APTS in the planning process?*

Not Important		Somewhat Important		Very Important	

4. *What level of efficiencies do you expect from APTS?*
5. *What is the primary motivation for APTS?*

Safety		Efficiency		Service Effectiveness	

6. *How do you think APTS will be made more effective in Florida?*
7. *What factors, in your view, impede the deployment of APTS? How do we overcome these barriers?*
8. *What is the role of various players (FDOT Central Office, FDOT Districts, MPOs and local government) in the development and deployment of APTS?*

FUNDING

1. *How important is it to provide funds for APTS in Public Transportation projects?*

Not Important		Somewhat Important		Very Important	

2. *How important is it to seek funding for APTS?*

Not Important		Somewhat Important		Very Important	

3. *What percent of the budget should be allocated to APTS?*

4. *What specific funding sources have been used for APTS?*

INTEGRATION

1. *How important is it for the regional ITS architecture to conform to the national ITS architecture?*

Not Important		Somewhat Important		Very Important	

2. *How would you define what conformity is?*

3. *What do you believe are the implications for APTS as a result of a statewide ITS strategic plan?*

4. *Have you been following the progress of the statewide architecture project?*

5. *How important is it for individual ITS-Transit projects to fit into overall architecture?*

Not Important		Somewhat Important		Very Important	

6. *Should that architecture be statewide, regional or local?*

7. *Do you think it is important to merge APTS into the regional ITS architecture?*

Not Important		Somewhat Important		Very Important	

8. *How can APTS be integrated into the regional ITS architecture?*

9. *Do you think transit should be combined with regional transportation services and traffic operations in a regional transportation management center?*

10. *What specific inter-local agreements and memorandum letters of understanding would be necessary to accomplish this?*

11. *Do you think it is important to integrate the following within a route, city, region, or state?*

Technology	Route	City	Region	State
Automatic Vehicle Location System				
Automatic Passenger Counters				
Vehicle Component Monitoring Systems				
Automated Operations Software				
On-board Safety Systems				
Traveler Information System				
Automated Fare Payment Systems				
Multi-carrier Reservation and Billing				
Automated Services (Scheduling, Routing, Information Systems)				
Traffic Signal Priority				
Integrated Billing Systems				
Advanced Communication Systems				
Automated Paratransit Systems				
Dynamic Ridesharing				

12. *Is it important to have traffic signal priority on your routes for transit vehicles?*

Yes	*No*

EQUIPMENT COMPATIBILITY

1. *Which of the following technologies should there be uniformity across route, city, region, or state?*

Technology	Route	City	Region	State
Automatic Vehicle Location System				
Automatic Passenger Counters				
Vehicle Component Monitoring Systems				
Automated Operations Software				
On-board Safety Systems				
Traveler Information System				
Automated Fare Payment Systems				
Multi-carrier Reservation and Billing				
Automated Services (Scheduling, Routing, Information Systems)				
Traffic Signal Priority				
Integrated Billing Systems				
Advanced Communication Systems				
Automated Paratransit Systems				
Dynamic Ridesharing				

STAFF OPINIONS

1. *Please give us your opinions on:*

Description	Procurement Methods[1]	Type	Manufacturers
Automatic Vehicle Location System			
Automatic Passenger Counters			
Vehicle Component Monitoring Systems			
Automated Operations Software			
On-board Safety Systems			
Traveler Information System			
Automated Fare Payment Systems			
Multi-carrier Reservation and Billing			
Automated Services (Scheduling, Routing, Information Systems)			
Traffic Signal Priority			
Integrated Billing Systems			
Advanced Communication Systems			
Automated Paratransit Systems			
Dynamic Ridesharing			

Note: 1. Products and/or services

2. *Please give us your opinions on:*

Description	Performance Ratings	Recommendations for Change
Automatic Vehicle Location System		
Automatic Passenger Counters		
Vehicle Component Monitoring Systems		
Automated Operations Software		
On-board Safety Systems		
Traveler Information System		
Automated Fare Payment Systems		
Multi-carrier Reservation and Billing		
Automated Services (Scheduling, Routing, Information Systems)		
Traffic Signal Priority		
Integrated Billing Systems		
Advanced Communication Systems		
Automated Paratransit Systems		
Dynamic Ridesharing		

3. *How important is it to have high occupancy vehicle lane access for transit vehicles? (This is a device/transponder on the vehicle, which gives access to high occupancy vehicle only lanes).*

Yes	*No*

4. *Please give us your opinions on:*

Description	**Measurable Benefits**	**Problems**[1]
Automatic Vehicle Location System		
Automatic Passenger Counters		
Vehicle Component Monitoring Systems		
Automated Operations Software		
On-board Safety Systems		
Traveler Information System		
Automated Fare Payment Systems		
Multi-carrier Reservation and Billing		
Automated Services (Scheduling, Routing, Information Systems)		
Traffic Signal Priority		
Integrated Billing Systems		
Advanced Communication Systems		
Automated Paratransit Systems		
Dynamic Ridesharing		

Note: 1. Are the problems with coordination, compatibility, or standards? (Coordination – Cor; Compatibility – Com; Standards – Std)

5. *Please give us your opinions on:*

Description	**Benefits Analysis**[1]	**Impacts**[2]
Automatic Vehicle Location System		
Automatic Passenger Counters		
Vehicle Component Monitoring Systems		
Automated Operations Software		
On-board Safety Systems		
Traveler Information System		
Automated Fare Payment Systems		
Multi-carrier Reservation and Billing		
Automated Services (Scheduling, Routing, Information Systems)		
Traffic Signal Priority		
Integrated Billing Systems		
Advanced Communication Systems		
Automated Paratransit Systems		
Dynamic Ridesharing		

Notes: 1. Was a benefits analysis done prior to deployment and post deployment? If so, what were the results?
2. What were the impacts to agency's staff and maintenance during operations?

Public Awareness/Involvement

1. *Are you satisfied with the level of public awareness of APTS?*

2. *Are you satisfied with the level of public official awareness of APTS?*

3. *What do you think are appropriate methods to increase public awareness?*

Partnering

1. *Is your agency currently partnering or intend to partner with a public or private entity? If yes, for what product(s) or service(s)?*

2. *What opportunities do you think exist for public-public and public-private partnerships for APTS?*

Rural Areas

1. *What benefits do you see in applying APTS in rural areas?*

Visions of the Future

1. *How would you describe the level of APTS success in your area?*

2. *If successful, what are the factors for your success?*

3. *What activities are necessary to assure and maintain success?*

4. *Do you think the ITS Strategic Plan will encourage more coordination for ITS-Transit projects between local governments and transit agencies?*

5. *What is your long-term vision of APTS for the future?*

Bus Rapid Transit

(Federal Transit Administration (FTA) is promoting Bus Rapid Transit in the United States through this initiative, upgraded bus service will include some or all of the following features: adaptive signal timing; exclusive right-of-ways; queue-jumper intersections; enhanced bus stops/stations; pre-paid fare instruments or electronic fare collection systems; vehicle location systems; buses with low floor, wider doors, and greater maneuverability; on-board passenger information systems; transit-oriented development land use provisions; and multiple bus service strategies including line haul, skip stop, express, neighborhood distributor, line haul feeders, and circumferential routes.)

6. *Do you think Bus Rapid Transit should be integrated into our surface transportation system?*

7. *Which of the above features should be included in Bus Rapid Transit?*

Intelligent Vehicle Initiative

(The mission of the Intelligent Vehicle Initiative (IVI) is to accelerate the development and availability of advanced safety and information systems applied to all types of vehicles. Its primary goal is to help drivers operate vehicles more safely and effectively. There are several bus systems that are in varying degrees of demonstrations concerning IVI technology. These include side collision warning, rear collision warning, front collision warning, lane keeping, precision docking etc.)

8. *Do you think it is important to incorporate IVI in transit?*

APPENDIX C
Interview Questionnaire for APTS Stakeholders

INTERVIEW FOR APTS STAKEHOLDERS

Person(s) Interviewed:	
Address:	
Telephone No.:	
Email Address:	

INTRODUCTION

I. Are you familiar with ITS?

II. Are you aware of what APTS is?

Advanced Public Transportation Systems (APTS) encompass the application of advanced electronic technologies to the deployment and operation of high occupancy, shared-ride vehicles, including conventional buses, rail vehicles, and the entire range of para-transit vehicles. They hold immense potential for improving mass transportation services and will be used to inform travelers of the alternative schedules that are available for any given trip, including the most advantageous routing.

APTS can also automatically handle trip fares. APTS will keep the traveler informed, in real time, of any system changes that occur and will respond to changes in the traveler's plans. APTS technologies will help vehicle system administrators manage a safe and efficient fleet and plan services to meet a broad range of consumer needs; they will allow the community to manage its roadways with special accommodations for high occupancy vehicles.

They will, in essence, enable transit authorities to provide a more flexible, cost effective, user-friendly service to their customers.

1. ITS-transit is called Advanced Public Transportation Systems (APTS).
2. Advanced Public Transportation Systems are advanced communication, navigation, computer and information technologies applied to Transit.
3. APTS consists of various parts such as:
    a. Fleet Management: It incorporates the many of the vehicle-based APTS technologies and innovations for more effective vehicle and fleet planning, scheduling and operations. Communication Systems; Geographic Information Systems; Automatic Vehicle Location; Automatic Passenger Counters; Transit Operations Software; Traffic Signal Priority Treatment.
    b. Traveler Information: With links to automatic vehicle location systems, traveler information systems are beginning to provide real-time transit information, such as arrival times, departure times, incidents, and delays. Travelers can access this information through a variety of media. Pre-trip; In-Terminal/Wayside; In-Vehicle.
    c. Electronic Fare Payment Transit, like other service areas, has the desire to reduce the use of cash payments while improving customer convenience. Various cards like smart cards, proximity cards, credit cards, magnetic stripe cards are used in electronic fare payment.

d. Transportation Demand Management Transportation (TDM) technologies are those, which combine innovative approaches and advanced technologies to better utilize existing infrastructure. This is accomplished through a combination of, among the other things, increased incentives towards shared rides, coordination of transportation service providers, and enhanced incident management. There are mainly four TDM technologies. Dynamic Ridesharing; Automated Service Coordination; Transportation Management Centers; High Occupancy Vehicle Facility Monitoring.

DEVELOPMENT AND DEPLOYMENT

I. *What are your views on ITS?*

II. *How important is APTS compared to other ITS applications?*

Not Important		Somewhat Important		Very Important	

III. *Do you think APTS will improve the performance of public transportation?*

No Improvements		Some Improvements		Significant Improvements	

IV. *How important is it to include APTS in the project development process?*

Not Important		Some What Important		Very Important	

V. *Are you promoting any particular APTS projects?*

VI *What is your overall view of APTS?*

VII. *How do you think APTS will be made more effective in Florida?*

VIII. *What factors, in your view, impede the deployment of APTS? How do we overcome these barriers?*

IX. *What is the role of various players (FDOT Central Office, FDOT Districts, MPOs and local government) in the development and deployment of APTS?*

FUNDING

I. *Should the state and the local governments be investing more in APTS?*

II. *What specific funding sources have been used for APTS?*

III. *Do you know how TEA 21 views funding sources for APTS?*

The following is a list of some of the views: (Excerpts from interview with William Millar, President of American Public Transit Association).

- TEA 21 puts the federal government's seal of approval on ITS in general and transit ITS in particular.
- One of TEA 21's major themes is the importance of open architecture and standards designed to ensure that a region's diverse ITS users have compatible technology, including the transit agency.
- More specifically, TEA 21 makes it clear that ITS is an eligible project cost under a wide variety of federal surface transportation programs, provided that the ITS investments meet the federal open architecture standards.
- TEA 21 makes it clear that transit-ITS expenditures can come from many programs, especially the flexible highway programs such as the Surface Transportation Program and CMAQ, and also the various elements of the transit program.

IV. *How important is it to seek funding for APTS?*

Not Important		Somewhat Important		Very Important	

V. *Do you think any part of the work program budget should be allocated to APTS?*

INTEGRATION

I. *How important is it for the regional ITS architecture to conform to the national ITS architecture?*

Not Important		Somewhat Important		Very Important	

II. *How would you define what conformity is?*

III. *What do you believe are the implications for APTS as a result of a statewide ITS strategic plan?*

IV. *Have you been following the progress of the statewide architecture project?*

V. *How important is it for individual ITS-Transit projects to fit into overall architecture?*

Not Important		Somewhat Important		Very Important	

VI. *Should that architecture be statewide, regional or local?*

VII. Do you think it is important to merge APTS into the regional ITS architecture?

Not Important		Somewhat Important		Very Important	

VIII. How can APTS be integrated into the regional ITS architecture?

IX. Do you think transit should be combined with regional transportation services and traffic operations in a regional transportation management center?

X. What specific inter-local agreements and memorandum letters of understanding would be necessary to accomplish this?

The following are some of the advantages of integrating transit and traffic functions in a TMC:

- Reduce jurisdictional issues
- Improve joint incident management
- Develop special event plans

PUBLIC AWARENESS/INVOLVEMENT

I. Are you satisfied with the level of public awareness of APTS?

II. What do you think are appropriate methods to increase public awareness?

PARTNERING

I. What opportunities do you think exist for public-public and public-private partnerships for APTS?

RURAL AREAS

I. What benefits do you see in applying APTS in rural areas?

VISIONS OF THE FUTURE

I. How would you describe the level of APTS success in your area?

II. *What activities are necessary to assure and maintain success?*

III. *Do you think the ITS Strategic Plan will encourage more coordination for ITS-Transit projects between local governments and transit agencies?*

IV. *What is your long-term vision of APTS for the future?*

Bus Rapid Transit

(Federal Transit Administration (FTA) is promoting Bus Rapid Transit in the United States through this initiative, upgraded bus service will include some or all of the following features: adaptive signal timing; exclusive right-of-ways; queue-jumper intersections; enhanced bus stops/stations; pre-paid fare instruments or electronic fare collection systems; vehicle location systems; buses with low floor, wider doors, and greater maneuverability; on-board passenger information systems; transit-oriented development land use provisions; and multiple bus service strategies including line haul, skip stop, express, neighborhood distributor, line haul feeders, and circumferential routes.)

V. *Do you think Bus Rapid Transit should be integrated into our surface transportation system?*

VI. *Which of the above features should be included in Bus Rapid Transit?*

Intelligent Vehicle Initiative

(The mission of the Intelligent Vehicle Initiative (IVI) is to accelerate the development and availability of advanced safety and information systems applied to all types of vehicles. Its primary goal is to help drivers operate vehicles more safely and effectively. There are several bus systems that are in varying degrees of demonstrations concerning IVI technology. These include side collision warning, rear collision warning, front collision warning, lane keeping, precision docking etc.)

VII. *Do you think it is important to incorporate IVI in transit?*

APPENDIX D
List of Participating Stakeholders

List of FDOT District 1 stakeholders (meeting attendees):

1. Commissioner **David R. Mills**, Sarasota County
2. Commissioner **Janet Shearer**, Polk County
3. Commissioner **John Albion**, Lee County
4. **David Hope**, Transit Manager, Collier County BCC
5. **Debbie Hunt**, Director of Planning & Public Transportation, FDOT
6. **Jay Goodwill**, Transit Director, SCAT
7. **John Starling**, District Public Transportation Manger, FDOT.
8. **Lisa B. Beever**, MPO Coordinator, Charlotte County-Punta Gorda
9. **Ralph Mervine**, Director of Operations, FDOT
10. **Robert Herrington**, for **Mike Guy**, Planning Manager for Sarasota/Manatee MPO

List of FDOT District 2 stakeholders (meeting attendees):

1. **Aage Schroder**, FDOT, District 2, Director of Planning
2. **Lorenzo Alexander**, FDOT, District 2, Public Transportation Manager
3. **Randy Warden**, for **Jim McLaughlin**, FDOT, District 2, Director of Operations

List of FDOT District 4 stakeholders (meeting attendees):

1. **Jeff Weidner**, Transit Supervisor
2. **Jonathan Overton**, District ITS Engineer
3. **Mark Plass**, Traffic Operations
4. **Tahira Faquir**, for **James Wolfe**, Director of Operations

List of FDOT District 6 stakeholders (meeting attendees):

1. **Arvind Kumbhojkar**, FDOT, District 6, ITS Administrator
2. **Carlos Roa**, Miami-Dade MPO, Transportation System Specialist
3. **David Fialkoff**, MDTA, Chief of Services and Mobility
4. **David Korros**, for **Rafael DeArazoza**, FDOT, District 6, Planning Manager
5. **Gary Donn**, FDOT, District 6, Director of Planning
6. **Gus Pego**, FDOT, District 6, Director of Operations
7. **Rene Rodriguez**, FDOT, District 6, Public Transportation Manager

List of FDOT District 7 stakeholders (meeting attendees)

1. **Bill Wilshire**, FDOT District 7, ITS Engineer
2. **Don Skelton**, FDOT District 7, Director of Planning and Public Transportation
3. **Jerry Karp**, FDOT District 7, Planning Department
4. **Harry Reid**, FDOT District 7, Public Transportation Manager
5. **John Temple**, FDOT District 7, Director of Operations

List of FDOT Central District stakeholders (meeting attendees)

1. **Wes Watson**, Florida Transit Association
2. **Liang Hsia**, FDOT, Deputy State Traffic Operations Engineer
3. **Mary Constiner**, FDOT, Transportation Disadvantaged Commission
4. **Ike Ubaka**, FDOT, Transit Planner
5. **Jack Brown**, FDOT, State Traffic Operations Engineer
6. **Howard Glassman**, FDOT, MPOAC Executive Director

List of Community Transportation Coordinator stakeholders (survey respondents)

1. **Rich Weingarten**, Charlotte County Transit Department, Charlotte County
2. **Michael D. Perry**, Sarasota County Area Transit, Sarasota County
3. **Brenda G. Clay**, Liberty County Board of County Commissioners, Liberty County
4. Pasco County Public Transportation, Pasco County
5. **John Stanley**, JTrans, Jackson County
6. **James Swisher**, Suwannee Valley Transit Authority, Columbia/Hamilton/Suwannee Counties
7. **Tim Banks**, COMSIS Mobility Services, Inc., Hardee/Highlands/Okeechobee Counties
8. **Gary Bryant, Rob Bowman, Carl Kerstan**, Good Wheels, Inc., Glades/Hendry Counties
9. **Jerry Lamm**, Citrus County Transit, Citrus County
10. **Steven E. Jones**, Flagler County Council on Aging, Flagler County
11. **Barbara Bertolini Timmerman**, Council on Aging of Martin County, Inc., Martin County
12. **David Hope**, Collier County Board of County Commissioners, Collier County
13. **Matt Pearson**, Suwannee River Economic Council, Bradford/Dixie/Gilchrist/Lafayette Counties
14. **Boyd Thompson**, Ride Solution, Putnam County
15. **Frank Ferry**, Clay County Council on Aging, Inc., Clay County

APPENDIX E

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