Iowa Department of Transportation

Office of Public Transit

Statewide Transit Intelligent Transportation Systems Deployment Plan

Rural and Small Urban Transit Systems

FINAL REPORT

October 2002

TranSystems Corporation

Multisystems

INTELLIGENT WIRELESS SYSTEMS®

Funding for the project was made available by the Federal Transit Administration and the Iowa Department of Transportation.

The report may be viewed on the Office of Public Transit Web Site: http://www.iatransit.com

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Glossary

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

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

Baud - A measure of data transmission speed.

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

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

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

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

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

Delayed Data Capture - Data that is viewed and used at a later time than the time of capture.

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

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

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

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

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

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

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

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

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

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

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

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

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

Society of Automotive Engineers (SAE) - An organization whose members share information, exchange ideas, and develop standards for advancing the engineering of mobility systems.

Scheduling Software - See Transit Operations Software.

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

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

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

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

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

Vehicle Area Network (VAN) Standard- The VAN (Vehicle Area Network) is a modern communication protocol. It provides a common backbone by which ITS systems and data can be linked on a vehicle.

SUMMARY

Iowa Department of Transportation

TRANSIT ITS

In early 2002, the Iowa Department of Transportation engaged a consultant to help develop a statewide transit ITS plan. Iowa DOT intended to provide a means for transit agencies in the state's rural and small urban communities to utilize Intelligent Transportation Systems (ITS) applications to support and enhance transit operations. Although several of the state's transit agencies have implemented ITS applications, most agencies continue to rely on manual procedures for operations, management, and customer service functions.

This endeavor is a logical extension of Iowa's planning and deployment in the ITS arena. In 2001 Iowa DOT completed a project to produce a statewide ITS deployment plan[1].

While the project has been technology-oriented, it also supports the broader objectives of the State of Iowa as well as the participating communities. Foremost among these objectives is to provide efficient and effective transit services that meet the needs of rural and small urban communities. The implementation of technology is, therefore, not for technology's sake; it is to improve transit services. ITS technology is a tool, and the project has defined a way of deploying these tools to serve transit agencies and transit users throughout the state.

Transit Intelligent Transportation Systems (Transit ITS) refers to electronics, communications or information processing technology that is specifically designed to provide or manage information for a function or functions within a transit system. Such functions include conducting on-street operations, providing passenger information, performing maintenance activities, and performing planning related analyses. The technologies can be used separately or as part of a bundle of technologies. Examples include hardware and software systems that schedule passenger/vehicle trips; track the location of vehicles and passengers; provide real-time or static service information; account for operating, human, and financial assets; and assist in the planning of system services. Transit ITS does **not** include hardware or software that has wide application such as word processing, spreadsheets, and general database management. While such hardware and software can be used to provide or manage information, they are not typically designed for a function or functions within a transit system.

The Transit ITS Deployment Plan is an initial step in the overall ITS deployment process. Experience from around the country has shown that initial planning is critical, and is too often an activity that is not given adequate time or resource. Thus, the project approaches the task of ITS deployment in several steps or phases.

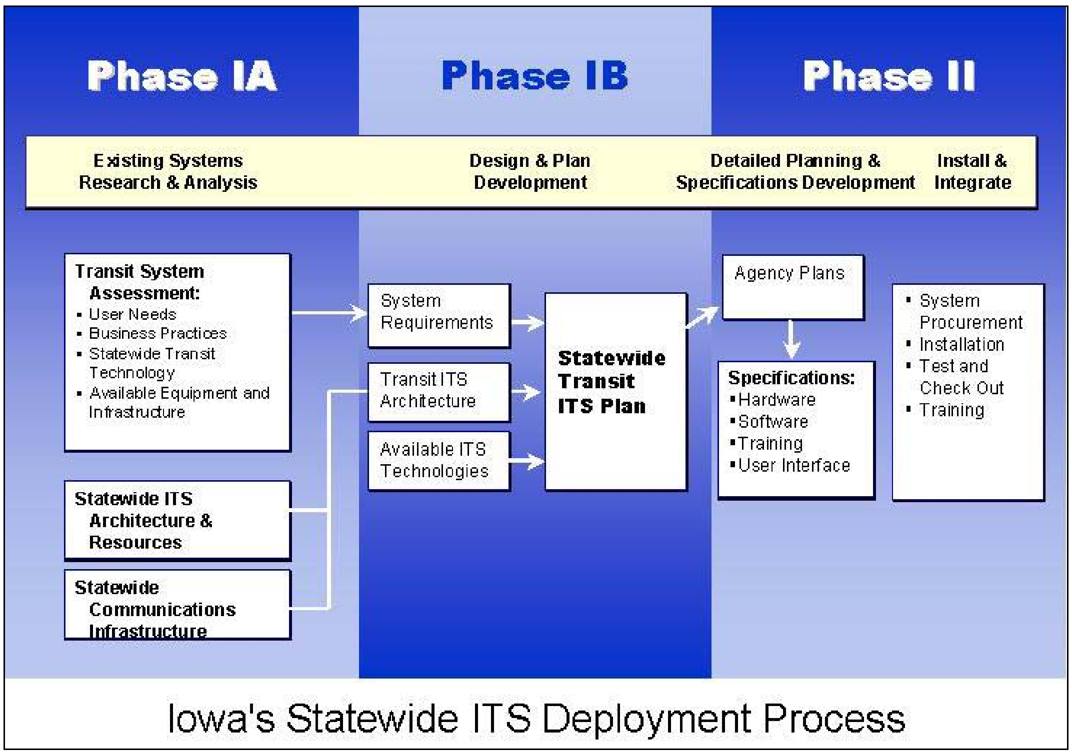
Phase IA was primarily an information gathering stage. During Phase IA an assessment was conducted to gain an understanding of how each transit agency operates, and the environment they operate in.

[1] Iowa DOT Integrated ITS and Services Deployment Plan, Draft Report, July 2001.

Phase IB was the general planning step. In Phase IB information was consolidated and synthesized, and the statewide Transit ITS plan was formulated.

The following graphic shows how the Phase I assessment and planning relate to implementation phase activities. Phase II will begin with the conclusion of Phase IB.

Figure 1
Iowa Transit ITS Deployment Plan Phasing



Available ITS Technologies for Transit Applications

Past research and experience with transit ITS applications have provided a “starting point” for potential applications in the state of Iowa. This project assesses ITS technologies that are most relevant to the needs of the Iowa transit agencies that were identified during the Phase IA assessments.

Generally, ITS applications for transit are categorized into five categories as shown in Figure 2 on the following page. The benefits listed in Figure 2 are those realized by other agencies that have deployed these ITS application. Additional information on these technologies is provided in the following paragraphs.

Geographic Information Systems (GIS)*.* Most transit operations software has an underlying need for mapping. GIS uses a database that links data with a geographic location, coupled with a map to display the data based on its location. Although GIS software can be used standalone for planning purposes, it is also used as a foundation technology to support the various types of transit operations software discussed below.

Figure 2
Transit ITS Applications and Benefits

Fleet Management Systems	▪ Increased transit safety and security ▪ Improved operating efficiency ▪ Improved transit service and schedule adherence ▪ Improved transit information
Operational Software and Computer-Aided Dispatching Systems	▪ Increased efficiency in transit operations ▪ Improved transit service and customer convenience ▪ Increased compliance with transit Americans with Disabilities Act (ADA) requirements
Electronic Fare Payment Systems	▪ Improved security of transit revenues ▪ Increased customer convenience ▪ Expanded base for transit revenue ▪ Reduced fare collection and processing costs ▪ Expanded and more flexible fare structures
Advanced Traveler Information Systems	▪ Increased transit ridership and revenues ▪ Improved transit service and fixibility within the community ▪ Increased customer convenience ▪ Enhanced compliance with Americans with Disabilities Act
Transit Intelligent Vehicle Initiative	▪ Increased safety of transit passengers ▪ Reduced costs of transit vehicle maintenance and repairs ▪ Enhanced compliance with Americans with Disabilities Act

Source: Benefits Asessment of APTS Technologies Update 2000

Reservations and Scheduling. Reservations and scheduling technologies include fixed-route and demand response applications.

Fixed Route Scheduling
Fixed route schedules are developed or updated on a periodic basis (e.g., once every six months). The process involves allocating the available fleet to the route structure and stops to develop the scheduled trips for the service period. Trips are then chained together to form runs for assignment to individual driver shifts. Fixed route scheduling software automates this time consuming runcutting process, and helps to ensure that the full range of potential scheduling alternatives is considered and that the schedules optimize the use of all possible resources.

Paratransit/Demand Response[2]
Software is available that can streamline and support the call-taking and reservations process, including real-time trip scheduling during the reservations process. The

[2] Note: Although the term "demand response" is used in Iowa to describe a range of transit service types that are not fixed route scheduled services, this report will use the term "paratransit." Demand response is defined as a service that changes daily as the needs of the users change, as differentiated from subscription service wherein the service patterns are substantially the same from day to day, and the users are regular "subscribers" to the service.

software is initially used to assist in certifying rider eligibility. This includes entering information about each rider into a registration database, such as name, address, phone number, and trip subsidy funding sources. By including address information, the rider's home location is "geocoded", meaning that the location can be automatically displayed on the GIS map when "home" is used as the trip origin or destination during a reservation.

Once the origin, destination, and required pick-up (or drop-off) time are defined in the reservation, the scheduling software will propose one or more vehicle runs. On this basis, the call taker is able to select the best run option, and to confirm the scheduled pick-up and drop-off time windows with the rider during the reservation call.

Technology cannot determine what institutional relationships are best for the service coordination possibilities between paratransit agencies, funding organizations, and service providers. However, the capabilities of advanced paratransit reservations and scheduling software, coupled with wide area networking technology, can enable new service coordination options. Such wide-area networking can allow all of the participants to be connected to use the reservations and scheduling software. This means that any call-taker could directly schedule the trip during the reservation process.

Transit Operations. Three transit operations technologies are discussed below.

<u>Data Communications and Mobile Data Terminals (MDTs)</u>
MDTs are small special purpose computers mounted near the driver, with a small keypad and display to provide an interface with a mobile data communication system.

MDTs support text messaging between drivers and dispatch. In a paratransit operation, text messaging can help improve efficiency by transmitting the trip manifest for the run directly to the vehicle (i.e., rather than being printed off for the driver as a paper manifest), as well as any real-time manifest changes during daily operations. The driver can use the MDT to indicate the completion of each pick-up and drop-off, and this information can be transmitted back to dispatch in real-time. As discussed below, MDTs can enable further enhancements to daily operations through computer-aided dispatch (CAD) and automatic vehicle location (AVL) software.

Two additional types of text messages that MDTs can support are alarms and vehicle maintenance monitoring. The MDTs can provide a silent alarm, which is unobtrusively mounted switch near the driver. This alarm, when activated, will covertly notify dispatch of an emergency situation. Vehicle maintenance monitoring circuits can be wired into MDT relays, that can be configured to send a text message to dispatch whenever a circuit detects a beyond threshold condition (e.g., coolant temperature, oil level).

<u>Computer Aided Dispatch (CAD)</u>
During daily operations, the dispatcher monitors deviations from the planned schedules of vehicles. A vehicle might pull out late, arrive early or late at a timepoint, or report a mechanical problem. This applies to both fixed route and paratransit operations.

Whenever these deviations are beyond a certain threshold (e.g., vehicle running more than five minutes late), the dispatcher may attempt to change the operating pattern of certain vehicles or assign a new vehicle and/or driver. CAD software helps the dispatcher identify and assess the feasible alternatives when operational problems occur, and keeps a comprehensive record of any changes that are made. Although CAD can operate using voice communications, MDT text messaging is often used to facilitate these processes.

Automatic Vehicle Location (AVL)

Even with CAD software support, the dispatcher must still be aware of vehicle locations. AVL software operating at a central dispatch location receives periodic location reports from each vehicle in the field and then updates the vehicle locations displayed on a GIS map (using symbols representing each vehicle). This time-stamped location data can also provide dispatchers with schedule adherence information by exception (this schedule adherence feedback is also often provided to the drivers on the MDT). The dispatcher can view detailed information about a particular vehicle, by clicking its map symbol or by checking a table that provides current information about the entire fleet.

The typical approach to generating the incoming vehicle location reports is to equip each vehicle with a Global Positioning System (GPS) receiver. The GPS receiver uses simultaneous signals from at least four GPS satellites to determine its current position within approximately 15 feet. The GPS equipment is integrated with an MDT, which sends the periodic location report to dispatch through a radio or modem.

Fleet Maintenance. Software programs can help automate vehicle maintenance tracking and analysis. Instead of recording maintenance activities in paper files, details can be recorded in a computer database. By building on the capabilities of commercial database management software, fleet maintenance software programs have been made easy to use with on-screen input forms. The database can also be used to periodically generate reports such as work orders, purchase orders, and reports for tracking and analyzing vehicle or staff performance indicators.

Transit User Information. Technology can enhance both the quantity and quality of the information available to the public. Applications include a variety of web-based systems that allow both static information and interactive systems for use in trip planning. Other applications include the installation of computer terminals in kiosk format at high-traffic public locations. Variable message signs can be installed at bus stop locations to provide both scheduled and real- time information to the public.

Because much of the information exchange between transit system managers and their customers is by telephone, particularly for paratransit operations, benefits can be secured through advanced telephone systems. Interactive Voice Response (IVR) systems may be useful for the larger transit systems that experience very high call volumes. At a minimum, all transit systems should have telephone voice mail or other recording systems that allow customers to communicate with the transit systems at all times of the day.

Fare Payment and Rider Identification. Electronic Fare Payment systems used in conjunction with MDT's and Transit Management software can form an integrated system to automate many of the administrative tasks involved with reporting and invoicing. These systems can be particularly beneficial to paratransit systems that typically have a higher level of reporting requirements to support funding sources. Electronic Fare Payment systems can also be used for trip verification.

Transit ITS Plan Outline for the State of Iowa

The Transit ITS Deployment Plan consists of two parts:

1. A Statewide Plan Framework that structures the approach to ITS deployment from the state's perspective.
2. General recommendations for individual transit agencies.

The following is a summary of the Statewide ITS Deployment Plan elements:

Communications Between Dispatch and Vehicles. Voice Communications is a fundamental requirement for transit operations. Data communications is a fundamental requirement for many ITS applications, especially those involving advanced operational applications.

Most Iowa transit systems have adequate voice communications using both RF and cellular, and varied frequencies. For applications requiring data communications, agencies will have to upgrade both radio hardware and radio service, in some cases requiring more capacity. Iowa DOT can assist transit agencies secure data communications, possibly through a partnership with radio service providers.

Transit Operations Management. Transit Operations Management software which includes GIS, reservations and scheduling software, Mobile Data Terminals (MDTs), Computer-Aided Dispatch (CAD) and Automatic Vehicle Location (AVL) have application based on the assessment of each system. Generally, the need for these management related applications increase as the size and complexity of the transit operation increases. It should be noted that some of these applications are required for other ITS applications, similar to building blocks. For example, AVL is a requirement for the provision of real-time information to customers.

Paratransit systems, due to their greater complexity, will more likely require Transit Management applications, such as CAD and scheduling. At a minimum, all of the state's paratransit systems should have computer-based systems to manage the client database and assist with the reservation/scheduling system.

Vehicle Maintenance Software. Software programs can help automate vehicle maintenance tracking and analysis. Instead of recording maintenance activities in paper files, details can be recorded in a computer database. The database can also be used to periodically generate reports such as work orders, purchase orders, and reports for tracking and analyzing vehicle or staff performance indicators.

Customer Service. A variety of applications exist to improve customer service functions, and make more information available to transit users. These applications range from advanced telephone systems to the provision of real-time transit schedule information.

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

Service Coordination. ITS applications make service coordination easier and the degree of coordination among agencies is likely to affect the design of systems. The plan suggests opportunities for service coordination among transit systems that can either be better accomplished with the use of technology, or may become part of the justification for service technology investment. For example, paratransit service coordination between urban transit agencies and adjacent regional transit systems may provide an opportunity for ITS deployment.

Cost and Funding. ITS applications are not inexpensive, and they usually have an ongoing cost associated with supporting the hardware and software systems. Initial acquisition costs and ongoing operating and maintenance costs have been estimated for each of the recommended applications. The Plan includes a funding strategy for transit ITS improvements developed in concert with the Steering Committee. Funding includes a mix of federal, state, and local funding.

Staging and Timing. The Plan includes a staging plan to logically implement ITS applications at the state's transit systems. The staged implementation of ITS is recommended as a means to allow a transit system to integrate new technology into its operation more gradually to ensure proper operation incrementally and to spread the funding requirement over a longer period of time. The staging plan must also allow for a logical sequence of implementation so that specific components rely on others previously deployed.

Institutional Arrangements. Transit in Iowa today is a partnership between individual transit agencies and the Iowa Department of Transportation. The ITS Deployment Plan suggests roles for the transit agencies and Iowa DOT. Because of the potential for economies through centralization of certain activities, Iowa DOT's role includes areas such as procurement, technical assistance, funding and technical support.

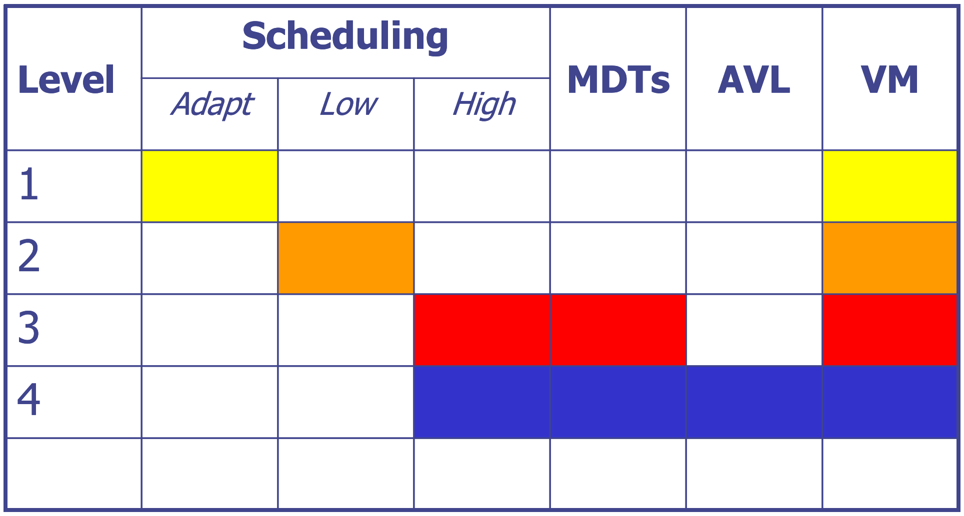
The possibility of creating a standing working group comprised of transit agency representatives should be explored. In concept, this working group can be an extension of the Steering Committee, and could have a role in recommending projects for funding to Iowa DOT. The working group could also serve as a resource as technology is deployed throughout the state. The creation of a transit ITS working group was recommended in the Iowa DOT statewide deployment plan.

Individual Transit Agency Plans:

The Statewide ITS project did not produce detailed deployment plans for each of the state's transit agencies per se. Rather, each of the state's 23 rural and small urban transit agencies were assessed and categorized into four Transit Technology Profiles (TTP) based on needs and factors such as size and scope of operations, complexity of service delivery, and degree of service coordination.

Figure 3 on the following page shows different profile levels along with the technology applications that may be associated with that level. The figure generalizes four levels of technology deployment. Level 1 is the simplest with Level 4 the most involved. Level 1 would implement two technology groups (scheduling and vehicle maintenance). Level 4 would use all four of the technology groups.

Figure 3
Technology Levels



Based on the Phase IA assessments and available technologies, an initial determination was made as to the TTP for each rural and small urban transit agency.

The technology needs of the transit systems were evaluated in greater detail during Phase IB of the project. This analysis, discussed in Section 7 of the report, resulted in revisions to the initial system technology assessment. The revised Phase IB transit system ranking is shown in Table 1 on the following page.

The four technology levels are summarized as follows: Level 1 is the simplest with Level 4 the most involved.

Level 1 includes small agencies with primarily fixed route services and small service areas. Many of the small urban areas are in this category. Two technology applications are recommended, scheduling and vehicle maintenance software. The scheduling system would either be a “low end” commercial package, or a system adapted from office spreadsheet and database software.

Level 2 includes mid-sized regional agencies. Two technology applications are recommended: scheduling and vehicle maintenance software.

Level 3 includes most of the regional transit agencies. Three technology applications are recommended: scheduling, vehicle maintenance software, and data communications. The data communications component may utilize less costly delayed data communications, rather than real-time data communications.

Level 4 includes the largest regional systems. This level would add AVL to the Level 3 applications.

Table 1
Phase IB Transit System Technology Assessment

Technology Level	System	Location
1	Mason City Transit Burlington Urban System Clinton Marshalltown MMT Muscatine Muscabus	Mason City Burlington Clinton Marshalltown Muscatine
2	Reg. 16 Southeast Iowa Reg. 6 Peoplerides	Burlington Marshalltown
3	Reg. 1 NRTS Reg. 14 Southern Iowa Reg. 7 Iowa Northland Reg. 2 North Iowa RTA Reg. 8 RTA Reg. 11 HIRTA Reg. 13 SWITA Reg. 12 Western Iowa	Decorah Creston Waterloo Mason City Dubuque Des Moines Atlantic Carroll
4	Reg. 5 MIDAS/DART Reg. 9 River Bend Transit Reg. 4 SRTS Reg. 3 RTA Reg. 10 East Central Iowa Reg. 15 Ottuma/10-15	Fort Dodge Davenport Sioux City Spencer Cedar Rapids Ottumwa

Note that Region 5 and DART, both in Fort Dodge, were combined during Phase IB.

Again, these assignments, and the technology applications that follow, are general. Based on this assessment Preliminary Agency Technology Deployment Plans were developed for each of the 21 agencies in Table 1. These preliminary plans show recommended applications, generalized initial and operating costs, an implementation schedule and a summary of potential benefits. The preliminary deployment plans are included in the appendix to this report.

Each agency will be required to develop a more detailed and specific Agency Plan in Phase II prior to the implementation of ITS technologies.

1.0 INTRODUCTION

This report summarizes the findings and conclusions of the Statewide Transit ITS Deployment Plan study. In early 2002, the Iowa Department of Transportation engaged a consultant to help it develop a statewide transit ITS plan. Iowa DOT intended to provide a means for transit agencies in the state's rural and small urban communities to utilize Intelligent Transportation Systems (ITS) applications to support and enhance transit operations. The project was a nine-month study of the needs and opportunities related to the expanded deployment of ITS applications by the state's transit agencies.

Complete project documentation is provided in a two-volume set of working papers and technical reports that have been delivered to the Iowa DOT Office of Public Transit and other study participants.

This report also summarizes specific recommendations that are the basis of the deployment plan.

1.1. Project Organization

A Steering Committee comprised of Iowa DOT staff and transit agency managers guided the study and reviewed the consultant's work products and conclusions. The members of the Steering Committee are:

Name	Title	Agency
Peggi Knight	Director, Office of Public Transit	Iowa DOT
Kay Thede	Senior Policy Analyst	Iowa DOT
Peter Hallock	Assistant Director OPT	Iowa DOT
Craig Markley	Transportation Planner	Iowa DOT
Willy Sorenson	ITS Engineer	Iowa DOT
Steve Andrle	Executive Director	CTRE/ISU
Dennis Kroeger	Research Associate	CTRE/ISU
Rose Lee	Executive Director	Regional Transit Authority – Region 3
Steve Jacobs	Executive Director	Region 8
Walt Stephenson	General Manager	Black Hawk County Metro Transit Authority
Rich Stone	Transit Administrator	Marshalltown
Pam Ward	Transit Administrator	Ottumwa Transit
Jeff Hanson	Transit Director	Siouxland Regional Transit System

The consultant team was lead by TranSystems Corporation, a Kansas City based transportation planning and engineering firm. Multisystems, Inc., a Cambridge transit planning firm with a transit technology specialty and Intelligent Wireless Systems, a Kansas City communications and technology firm were subconsultants.

The project included eight specific tasks:

Transit System Assessment. To assess the ITS needs and capabilities of Iowa's sixteen regional, seven small urban transit agencies and twelve large urban systems.

Statewide Communications Assessment. To assess the communications resources currently available in Iowa and in the short term to identify elements of the existing communications infrastructure that can be used to support Transit ITS applications.

Inventory of Statewide ITS Resources. To assemble an inventory of the ITS resources and initiatives in Iowa that may offer resource-sharing potential for the Transit ITS plan.

Assessment of Available Technology. To assess the availability of technologies on the market that address the ITS needs of Iowa's transit agencies.

Develop Statewide Transit ITS Architecture. To develop a statewide transit ITS architecture based on the draft architecture in the Iowa ITS plan and consistent with the national ITS architecture

Develop Application Evaluation Process. To develop criteria for deployment prioritization and strategies of proposed systems. Criteria should be based on increasing operating efficiencies, improving services, improving information and integration with other technologies, and increasing safety and security for passengers and drivers.

Evaluate Deployment and Procurement Strategies. To examine opportunities for economies through standardization and interoperability in Iowa. Consider procurement strategies.

Recommend Iowa's Transit ITS Plan. To present a transit ITS deployment plan for implementation in the 2002-2004 time frame.

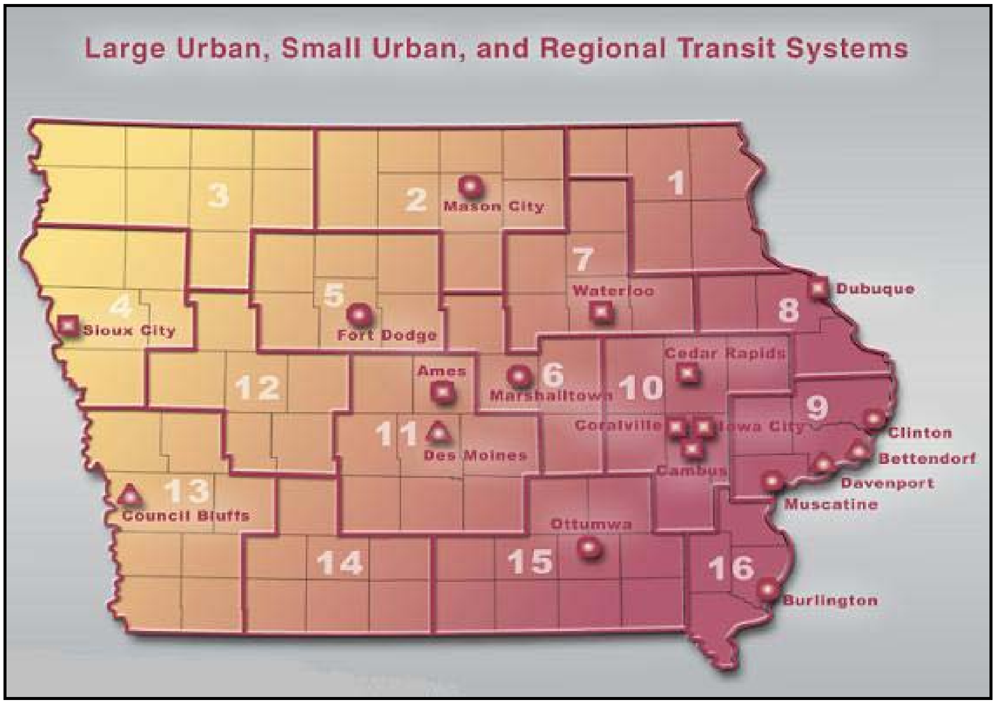
The Transit ITS Deployment Plan is divided into two parts:

1. A Statewide Plan Framework that structures the approach to ITS deployment from the state's perspective.
2. Recommendations for individual transit agencies.

1.2. Transit in the State of Iowa

At the end of 2001, thirty-five transit systems were operating in the State of Iowa. The Iowa Department of Transportation's Office of Public Transit grouped those systems as Regional (or rural), Small Urban, or Large Urban. Figure 1.1 illustrates the locations of these systems through out Iowa. Table 1.1 summarizes the characteristics of these systems. Together, Iowa's thirty-five systems had $64 million in annual operating costs and served just over 22 million annual passenger trips.

Figure 1.1
State of Iowa Public Transit Systems



Source: State Of Iowa, Department of Transportation Website.

LEGEND

Transit Systems in Urbanized areas >200,000 Population

Transit Systems in Urbanized areas 50,000 to 200,000 Population

Transit Systems in Small Urban areas <50,000 Population

16 Regional Transit Systems (Rural)

Just over half of Iowa's transit systems are "small" or "large" urban systems. Small and large urban systems are mainly fixed route services operating out of one location and serving mainly one city or county. Regional systems, on the other hand, are all mainly paratransit operations serving multiple counties, and typically have fleets operating out of more than one location.

There are two main types of regional systems. First, are those that directly operate their service. Thirteen of the sixteen systems fall in this category. Second are those systems called "brokerages". The host broker agency does not operate service. Rather, it contracts the provision of services to operators in its service area. The number of providers ranges from six for one regional broker to seventeen for another.

Table 1.1
Summary of Iowa Transit System Characteristics (2001)

Item	System Type			
	Regional/ Rural	Small Urban*	Large Urban*	All
Number of Systems	16	8	11	35
Total Annual Operating Costs	$19.4 million	$8.3 million	$36.4 million	$64.0 million
Total Annual Riders (000's)	3,943	4,526	13,787	22,256
Average Annual Operating Costs	$1.2 Million	$1.0 million	$3.3 million	$1.8 million
Contract Revenue % Annual Costs	40%	7%	9%	18%

**In 2002, the Ames transit system was re-classified as a large urban system from a small urban system. As the statistics are from 2001, Ames is reflected here as a small urban system.*

1.3. Large Urban System ITS Assessment

One of the tasks in the development of the statewide Transit ITS Deployment Plan was to assess the potential for ITS applications in the state's twelve large urban systems. Working Paper 4, Phase IA, documents the assessment of ITS potential in the state's large urban transit systems.

Although funds from the state's FHWA grant cannot be used directly for deployment in the large urban areas (metropolitan areas over 50,000 population) these transit systems are to be included in the statewide deployment plan. The statewide transit ITS architecture developed as part of the project accounts for ITS deployment in the large urban areas. In addition, coordination among transit systems of all sizes should be part of the plan. Finally, funds from the FHWA grant can be used for projects in the large urban areas if the project includes direct coordination with a regional system (e.g., where a large urban system serves as a host for a regional system).

The Phase IA conclusion was that there is a limited opportunity to deploy ITS technology in the state's large urban transit systems to realize benefits in operational efficiency and effectiveness. Most of these transit systems are not of the size or complexity that is associated with full deployment of ITS applications.

Because the transit systems operate in urban areas, including university communities, deployment of technology to support the provision of user information (scheduled or real-time) has potential. Dissemination of information through web sites and other such media could have greater application potential compared with rural areas.

Another opportunity is in the area of service coordination. The large urban areas are centers for medical services and other services that attract residents from the outlying areas. Many of the regional transit systems routinely transport their clients into these urban centers. ITS can enhance the capability of transit systems to coordinate services, including transfers.

Finally, because the large urban systems have access to more IT resources, and because of their central locations, there may be opportunities for large urban systems to host ITS applications for surrounding regional systems. For example, paratransit scheduling systems can support multiple users. A large urban system could procure the system, support the system and make the system's capabilities available to other transit systems. Several systems partner with adjacent regional systems for the provision of ADA paratransit service. This model represents another opportunity for sharing ITS resources.

Finally, any technology deployment in urban areas should be consistent with the state's Transit ITS Plan and the applications should employ similar standards and design features to ensure compatibility with similar systems in other parts of the state. Prior to embarking on significant ITS projects the large urban systems should conduct pre-planning studies and systems engineering to identify coordination and integration opportunities. ITS projects in urban areas must be consistent with the statewide Transit ITS architecture developed during this project.

1.4. Study Methodology

The Statewide Transit ITS Deployment Plan is based on an assessment of the needs and business practices of each small urban and regional transit agency in the state of Iowa. Site visits were conducted at each agency, which consisted of interviews with key agency staff, observations of work processes, and review of written materials to include external and internal reports. The results of these site visits were evaluated and compiled in a document entitled "Transit System Working Summaries – Regional and Small Urban Systems."

Site visits were also conducted at eight of the state's twelve large urban transit systems. Information from the site visits was augmented with a survey of each system designed to determine technology-related needs and plans for ITS deployment. This information is summarized in Working Paper 4, "Status and Potential for ITS Applications in Large Urban Areas."

Fundamentally, the purpose of the assessment was to determine the management systems and business practices in use at twenty-two of Iowa's transit systems. The goal of the assessment was to determine whether ITS applications could provide cost effective solutions. Another purpose was to determine the status and type of technology used by these transit agencies. This baseline assessment was obtained through a "hands-on" inventory of current operations.

Consultant project staff personally visited all twenty-two regional and small urban systems. Project personnel interviewed executive management as well as some of the front line operating personnel. Further, project staff obtained hard copy samples of reports and other information. System staff often demonstrated which information was collected and processed as well as how that information was used.

To facilitate these on-site interviews, the consultant team developed a concise questionnaire that was distributed to the rural and small urban transit agencies prior to the site visit. A similar survey was also sent to the large urban systems. Finally, for the systems that were "brokerages," the consultant worked with the host agencies to collect service provider data. The surveys generally covered these basic topics:

- Overview of system operations including institutional funding partners.
- Management and office procedures including internal and external reporting requirements and information flow.
- Street operations including method of driver work assignments and reporting.
- Fare collection procedures.
- Customer service.
- Vehicle maintenance.
- Perceived and actual agency barriers/opportunities for implementing advanced technology.

After site visits were completed, the transit systems were categorized by type of operation, level and type of technology currently in use, key problems and issues, and interest level in technology. "Technology Profile Levels" (TPL) were developed that grouped rural and small urban transit agencies by some common features. These TPLs will eventually set-up the task of developing a common migration strategy for developing and implementing technology statewide.

The general approach used to assess the various systems was to gauge those systems' level of business complexity. The more complex an operation from a "business information" point of view, the greater the need exists for technology. Small urban systems in Iowa are relatively straightforward operations with limited needs for advanced technology. Generally, the regional systems (all of which are rural transit providers) are complex operations that, because of limited resources, tend to improvise ways in which to provide services. Thus, they have varied needs for technology.

Rural transit systems are complex mainly because of the multitude of funding or revenue sources they use to finance their services. Rural transit systems are also complex because service areas are often dispersed among multiple counties with fleet and dispatching operations based out of more than one location. Forty percent of operating costs in rural areas are covered by contracted revenue. For the other systems in Iowa, less than ten percent of such costs are covered by such contracted relationships. Contract revenue is accrued when a system has an agreement to provide transportation services for an outside organization.

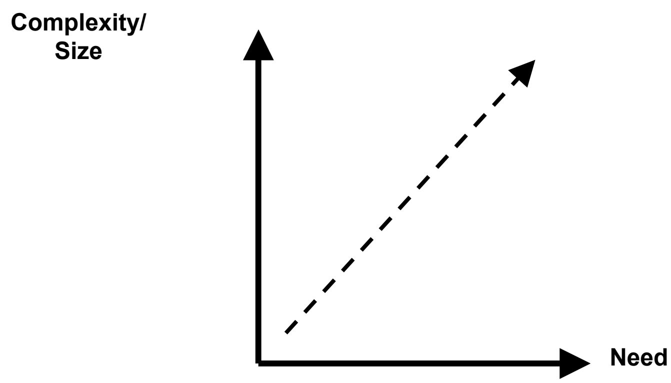
It is common for rural or regional systems in Iowa to have service contracts with a number of institutional clients. Clients include sheltered workshops and other social service agencies. Each of these clients typically has a unique process in which the transit system receives payment for services. Each invoice can be fairly detailed requiring each trip served to be individually documented as to time, location, and purpose. An example is with sheltered workshops that require a listing of trips by individual, including the date of the trip.

Determining Technology Needs

This section discusses the methodology for determining the preliminary technology needs for Iowa rural and small urban transit systems. These "needs" were embodied in "Technology Profile Levels" to be discussed below. These technology profiles classify Iowa small urban and regional transit systems according to similar technology needs.

The process of developing “Technology Profiles” involves organizing the various transit systems by key, defining characteristics. This process attempts to provide structure in relating the “business information complexity and dependency” to technology need. As shown in Figure 1.2, the more complex the system, or the greater its size, the greater the need for technology.

Figure 1.2
Relationship of System Complexity/Size and Technology Need



In general, these factors were weighed in determining how technology could support the business aspects of Iowa rural and small urban systems.

System Annual Operating Budget	Generally, the greater the budget, the greater the volume of information typically needed to support reporting requirements.
Percent of Contract Revenue	The higher the percent of contract revenue to total operating budget was an indicator of business complexity in dealing with involved reporting requirements.
Number of Vehicles	Generally, the greater the number of vehicles, the greater the need for technology. Usually, systems with 50 or more vehicles were ranked higher for technology need than systems with less than 50 vehicles. The only exception would be systems with budgets in excess of $1.5 million that had less than 50 vehicles were ranked higher because a higher budget indicated a degree of complexity.
Driver assignments	Decentralized or centralized method of assigning work to drivers. Drivers who are dispersed over a large service area and from multiple locations were seen as more complex than those systems operating out of one location.
Service Area	Systems operating in one county were seen as less complex than systems operating in multiple counties.
Outbound reporting	These refer to reports to entities outside the transit agency. The more complex and involved these reports, the greater the need for technology.

Service Type Fixed route operations were seen as less complex from an information-processing point of view than paratransit operations.

1.5. Other ITS Initiatives in Iowa

The Iowa DOT has been involved in a number of ITS projects over the past few years. The Integrated ITS and Services Deployment Plan documented recent Iowa DOT ITS initiatives. Within the Public Traveler/Public Mobility Services category, 17 initiatives across the state are in operation or under development, as documented in the Statewide Plan. These initiatives consist primarily of automatic vehicle location (AVL), computer-aided dispatch (CAD) systems, and internet-based traveler information. Table 1.2 summarizes these initiatives, which are in operation or under development.

Table 1.2
Summary of Iowa ITS Initiatives for Public Traveler/Public Mobility Services

Project		Description
1.	Des Moines Bus Schedules/Routes	Map of bus routes & schedules on internet
2.	Des Moines Vanpool/Carpool	Carpool/vanpool information and application forms on the Internet
3.	Global Positioning System (GPS) Transit Vehicle Tracking	Install GPS on transit vehicles for dispatching and tracking
4.	Other Transit Agency Schedules	Link to other bus schedules/routes on the Internet
5.	CAMBUS On-line Route Information	Transit route information available on the Internet
6.	Cedar Rapids CAD/AVL	Automatic Vehicle Location and computer-aided dispatch systems
7.	Cedar Rapids Automated Run-Cutting	Automated run-cutting
8.	Cedar Rapids On-board Surveillance	On-board surveillance of transit vehicles
9.	Des Moines CAD/AVL	Automatic Vehicle Location and computer-aided dispatch systems
10.	Iowa City Interactive Route Information Kiosks	Routes available at kiosks
11.	Iowa City On-line Route Information	Route information available on the Internet
12.	Sioux City CAD/AVL	Automatic Vehicle Location and computer-aided dispatch systems
13.	Waterloo CAD	Computer-aided dispatch systems
14.	Ames On-Line Route Information	Route information available on the Internet
15.	Ottumwa/Region 15 CAD/AVL	Automatic Vehicle Location and computer-aided dispatch systems
16.	Region 8 CAD/AVL	Automatic Vehicle Location and computer-aided dispatch systems
17.	Region 10/Johnson County CAD/AVL	Automatic Vehicle Location and computer-aided dispatch systems

Source: Integrated ITS and Services Deployment Plan, Draft Report – July 2001

This project has assembled a detailed inventory of the existing technology and ITS deployments of Iowa transit systems, additional to those discussed above. The *Transit Agency Site Visits Summary Reports* and *Working Paper 6: Inventory of Statewide ITS Resources* provide additional information on existing ITS projects and initiatives in the State. Additional ITS projects and initiatives in Iowa include:

511 for Traveler Information. The U.S.' national traveler information telephone number, 511, was designated in July 2000 by the Federal Communications Commission (FCC). Almost all implementation issues and schedules were left to state and local agencies and telecommunications carriers. Iowa DOT is leading a seven-state consortium that is developing a new 511 traveler information phone service. This service will be deployed during the next few years. Public transportation could conceivably be added to the initial information that will be provided to Iowans on 511. (Initial information to be provided on 511 in Iowa includes real-time statewide road condition and weather information.) Iowa has already developed the reporting and data acquisition systems for the 511 service. Using speech recognition, travel information databases will drive automated 511 voice messages without additional manual intervention.

Potential ITS for traveler information related to the reconstruction of I-235. Traveler information ITS applications may be used to communicate about the I-235 construction and to improve travel efficiency. IDOT is reviewing applications, such as I-235 email alerts, Highway Advisory Radio (HAR), and Variable Message Signs, to assist traffic during I-235 construction. These applications, in addition to other ITS applications for traffic monitoring and traffic management and safety, may be adopted by IDOT on a permanent basis if they meet transportation system objectives.

Weatherview. Real-time transportation-related weather updates can be accessed via the Internet at http://www.dotweatherview.com/. Continuously updated travel conditions help motorists plan ahead for local and/or long distance commutes and travel safety. Weatherview combines the Iowa DOT's Road Weather Information System (RWIS) with Automated Weather Observing Stations (AWOS) at Iowa's airports to serve as a powerful resource in assisting site visitors with their safety on Iowa's transportation system.

Iowa DOT Maintenance concept vehicle. A "concept" winter maintenance vehicle was developed beginning in 1995 by IDOT, the Michigan and Minnesota DOTs, and the Center for Transportation Research and Education (CTRE). IDOT's maintenance concept vehicle is a standard-issue snowplow truck outfitted with ITS technology and other state-of-the-art safety and information components. Drivers can make decisions about plowing and spreading material with assistance from information provided on a readout in the cab of the truck. Data can also be recorded and downloaded or transmitted to provide guidance on optimizing roadway treatments and addressing trouble spots. This information can also be transmitted to traffic management centers, ITS service centers, and rest areas to help motorists make better travel decisions.

CVISN. The term commercial vehicle information systems and networks (CVISN) refers to the ITS information system elements that support commercial vehicle operations (CVO) activities. CVISN includes information systems owned and operated by governments, carriers, and other stakeholders. A national CVISN architecture has been developed to provide states with a common information system platform for CVO.

FORETELL. FORETELL is a weather forecasting system that allows transportation professionals to disseminate appropriate weather conditions to motorists prior to making travel plans. Computers assist in identifying weather changes hours before actual occurrences so transportation officials and the public can make more accurate safety and travel decisions.

Condition Acquisition and Reporting System (CARS). The Condition Acquisition and Reporting System (CARS) allows agencies at all levels to report planned and unplanned construction detours, road conditions, and weather traffic events. The data is made available on the Internet for commercial travelers and private motor vehicle operators.

The National Model and the Department of Public Safety's Traffic and Criminal Software (TraCS). Law enforcement officers can efficiently collect, transmit and process data using special laptop computers installed in their vehicles. This helps expedite transportation-related incident reports and increase safety on our state's highways. The National Model originates from the Department of Public Safety's TraCS (Traffic and Criminal Software). TraCS is a statewide, automated system for the capture of police reported traffic crashes and was developed by the Iowa DOT.

IDOT Linear Referencing System (LRS) Project. IDOT is developing a linear referencing system (LRS) to integrate databases and mapping within various transportation systems and organizations, promoting consistency. The system's primary purpose is to improve IDOT business workflows and decision-making by improving the integration of disparate data using the data's roadway network location. The LRS is composed of people, data, tools, policies and technology that together support the DOT's data integration, analysis, and decision-making.

2.0 TRANSIT ITS ARCHITECTURE

Iowa Department of Transportation

TRANSIT ITS

This section updates the transit aspects of the Statewide ITS Architecture effort completed in 2000 in order to develop a Statewide Transit ITS Architecture (STIA)[3]. This update ensures that the STIA addresses the more detailed set of transit-related user needs identified throughout this project. It also considers the National ITS Architecture, on which the earlier effort had been based, which has been considerably revised since that time.

The STIA was developed using a similar methodology to the earlier effort, but began with an updated set of ITS needs that were identified during Phase IA for Iowa transit agencies. First, these needs were mapped to the User Services documented in the current National ITS Architecture. Then, these User Services were mapped to the National ITS Architecture Market Packages and Equipment Packages. The National ITS Architecture Subsystems associated with these Market Packages and Equipment Packages were used to develop the Architecture.

The STIA is based on the Market Packages and Equipment Packages that support the identified ITS needs for Iowa transit agencies, and as such represents a longer-term vision and framework for statewide transit ITS deployment. The Equipment Packages still must be prioritized to establish the sequence in which they would be deployed, and programmed based on the availability of funding (i.e., the Statewide Transit ITS Deployment Plan, which will be the final product of this study).

2.1. Transit ITS Needs

Table 2.1 summarizes the ITS needs identified for Iowa transit agencies, based on the findings of Phase IA.

2.2. Mapping ITS Needs to User Services

Table 2.2 presents the mapping of ITS needs to the User Services related to transit. Based on this mapping, most of these User Services were selected for inclusion in the STIA. However, the selected User Services were customized and do not necessarily use all of the functional capabilities associated with User Services in the National ITS Architecture (selected and customized User Services are shaded).

Table 2.3 describes the customized User Services that were selected, and highlights how they have been customized by identifying which functional capabilities are required to support the identified ITS needs of transit agencies in Iowa.

[3] Iowa Department of Transportation, "Iowa DOT Integrated ITS and Services Deployment Plan – Draft Report", July 2001

2.3. Mapping User Services to Market Packages and Equipment Packages

Table 2.4 presents the mapping of the selected User Services to the Market and Equipment Packages. Based on this mapping, all of the Market Packages were selected for inclusion in the STIA. However, the selected Packages were customized and do not necessarily use all aspects of those Packages as they appear in the National ITS Architecture (selected and customized Packages are shaded).

Table 2.5 shows which Equipment Packages are included in each customized Market Package, and highlights how the Equipment Packages have been customized by including a brief description of what types of technology would be included.

2.4. Transit Architecture

Figure 2.1 is the STIA diagram, mapping the transit ITS system elements selected for Iowa to the structured set of standard Subsystems and communications methods defined in the National ITS Architecture. This high-level architecture diagram focuses on the physical linkages between distinct entities. The Statewide Transit ITS Deployment Plan will address the prioritized implementation of individual deployment projects within this framework.

2.5. Conclusion

The following methodology was used to develop the Iowa Statewide Transit ITS Architecture (STIA):

- The identified transit ITS needs of Iowa transit agencies were used to select and customize appropriate User Services from the National ITS Architecture (Version 4.0).

- These User services were in turn used to select and customize appropriate Market Packages and Equipment Packages from the National ITS Architecture.

The high-level STIA has been developed to create a framework for future deployment. The STIA maps the transit ITS system elements selected for Iowa to the structured set of standard Subsystems and communications methods defined in the National ITS Architecture. The Statewide Transit ITS Deployment Plan will address the prioritized implementation of individual deployment projects within this framework.

Table 2.1
ITS Needs Identified for Iowa Transit Agencies

ITS Need Category	ITS Need	Needed Functionality
Transit Operations, Management And Maintenance	Paratransit reservations and eligibility	• Enhance call-taker productivity
	Fixed route and paratransit scheduling	• Identify runs that enhance productivity and customer service
	Centralized Dispatch	• Monitor fleet location and operational status • Rapid and accurate transmission of routine communications with drivers • Driver security
	Paratransit service coordination	• Consolidating invoices to funding agencies from multiple service providers • Access to scheduling capability for geographically distributed call-takers and service providers • Coordinate transfers across service area boundaries • Integrating fixed route transit into paratransit trips
	Fleet maintenance	• Enhance collection, processing, filing and analysis of maintenance information
Transit Information	Transfer connection protection	• Systematically decide when and for how long to hold outgoing buses at a transfer point if the incoming bus is delayed
	Pre-trip information and planning	• Distribution of static transit system information • Alternatives during off hours and peak times to calling customer service agents • Providing information about known service disruptions • Real-time information about estimated arrival times at major transfer locations
	In – vehicle next stop information	• Information for those with disabilities when approaching stops
Fare Payment and Rider Identification		• Reduce the use of cash • Reduce fraud with prepaid fare media • Enable agencies to accept each others fare media and equitably share revenue • Identify eligibility of paratransit riders to address funding agency requirements

Table 2.2
Mapping ITS Needs to User Services for Iowa Transit Agencies

	User Services										
ITS Needs	1.1 Pre-trip Travel Information	1.3 Route Guidance	1.4 Ride Matching and Reservation	1.6 Traffic Control	2.1 Public Transportation Management	2.2 En-Route Transit Information	2.3 Personalized Public Transit	2.4 Public Travel Security	3.1 Electronic Payment Services	5.1 Emergency Notification and Personal Security	7.1 Archived Data User Service
Paratransit Reservations and Eligibility							✓				✓
Fixed Route and Paratransit Scheduling							✓				✓
Centralized Dispatch							✓	✓			✓
Paratransit Service Coordination							✓				✓
Fleet Maintenance											✓
Transfer Connection Protection											✓
Pre-trip Information and Planning	✓	✓									✓
In-vehicle Next Stop Information						✓					
Fare Payment and Rider Identification									✓		✓

Table 2.3
Customized User Services for Iowa Transit Agencies

User Service Bundle	User Service	Functional Capabilities
1. Travel and Traffic Management	1.1 Pre-trip Travel Information	• Checking service hours and fares • Checking for current route cancellations or detours • Requesting a trip itinerary for the origin, destination and desired trip start or finish time.
	1.3 Route Guidance	• Provide transit route and schedule information • Provide information on major delays or estimated stop arrival times
2. Public Transportation Management	2.1 Public Transportation Management	• Dispatch support • Fleet maintenance support • Developing route schedules • Blocking and runcutting • Workforce management • Bidding • Voice communications • Mobile data communications
	2.2 En-Route Transit Information	• Using on-board location determination to provide next stop announcements
	2.3 Personalized Public Transit	• Paratransit eligibility and reservations • Automatic email and/or dial-out notice for trip confirmation and imminent arrival • Preparation and mobile data transmission for manifests • Dispatch support • Mobile data transmission of trip completion records • Paratransit trip scheduling • Funding provider invoicing • Voice communications • Mobile data communications
	2.4 Public Travel Security	• Driver covert alarm • Dispatch monitoring for driver alarms
3. Electronic Payment	3.1 Electronic Payment Services	• On-board payment using electronic farecards • Facilities for issuing, revaluing and accounting with electronic farecards • Paratransit rider identification using electronic farecards • Clearinghouse to allocate prepaid revenue between multiple transit agencies accepting a universal electronic farecard
7. Information Management	7.1 Archived Data	• Archiving historical data • Error checking on data as it is received • Interface for access to and analysis of historical data archives, including assistance with generating standard reports

Table 2.4
Mapping User Services to the Market Packages and Equipment Packages for Iowa Transit Agencies

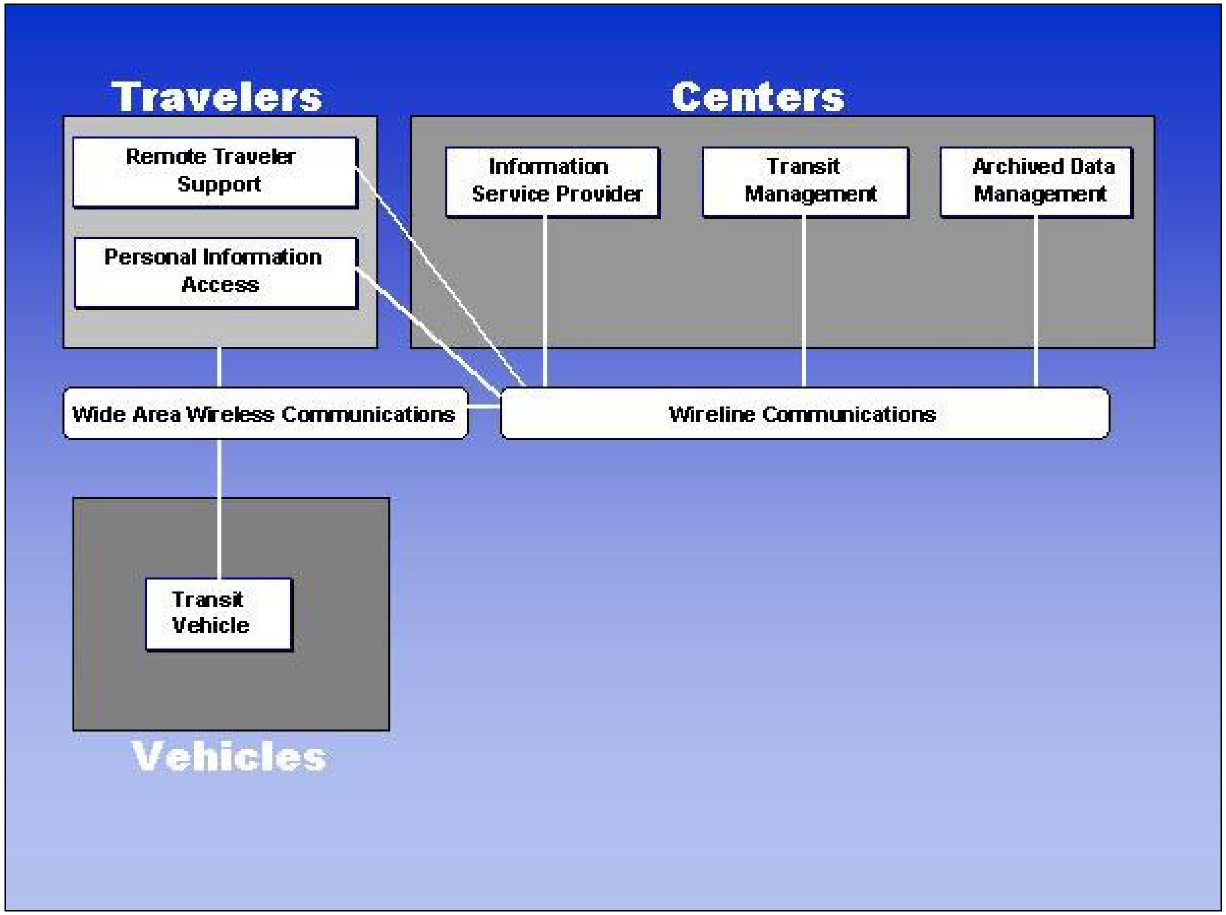
	Market and Equipment Packages																																		
User Services	**APTS1 Transit Vehicle Tracking**	**Transit Center Tracking and Dispatch**	**On-board Transit Trip Monitoring**	**Vehicle Location Determination**	**APTS2 Transit Fixed-Route Operations**	**Transit Center Fixed Route Operations**	**Transit Garage Operations**	**On-board Fixed Route Schedule Management**	**APTS3 Demand Response Transit Operations**	**Transit Center Paratransit Operations**	**Transit Garage Operations**	**On-board Paratransit Operations**	**APTS4 Transit Passenger and Fare Management**	**Remote Transit Fare Management**	**Transit Center Fare and Load Management**	**On-board Transit Fare and Load Management**	**APTS5 Transit Security**	**Remote Mayday Interface**	**Secure Area Monitoring**	**Transit Center Security**	**On-board Transit Security**	**APTS6 Transit Maintenance**	**Transit Garage Maintenance**	**On-board Maintenance**	**APTS7 Multi-modal Coordination**	**Roadside Signal Priority**	**Traffic Management Center Multimodal Coordination**	**Transit Center Multimodal Coordination**	**On-board Transit Signal Priority**	**APTS8 Transit Traveler Information**	**Interactive Infrastructure Information**	**Personal Interactive Information Reception**	**Remote Transit Information Services**	**Transit Center Information Services**	**On-board Transit Information Services**
1.1 Pre-trip Travel Information																														✓		✓		✓	
1.3 Route Guidance	✓	✓		✓																										✓		✓	✓		
2.1 Public Transportation Management	✓	✓	✓	✓	✓	✓	✓		✓		✓											✓	✓		✓			✓							
2.2 En-Route Transit Information	✓		✓	✓																										✓					✓
2.3 Personalized Public Transit	✓	✓	✓	✓					✓	✓		✓																✓							
2.4 Public Travel Security	✓	✓	✓	✓													✓				✓														
3.1 Electronic Payment Services			✓	✓									✓	✓	✓	✓																			
7.1 Archived Data	✓	✓			✓	✓	✓		✓	✓	✓		✓		✓		✓					✓	✓		✓			✓		✓		✓	✓	✓	

Table 2.5
Customized Market and Equipment Packages for Iowa Transit Agencies

Market Packages	Equipment Packages	Technology Elements
APTS1 Transit Vehicle Tracking	Transit Center Tracking and Dispatch	• Provide vehicle locations and schedule adherence information to dispatchers • Two-way mobile voice and data communications
	On-board Transit Trip Monitoring	• Mobile Data Terminals, to integrate all on-board devices, provide on-board processing capability, provide driver schedule adherence feedback and link to the mobile data communications system
	Vehicle Location Determination	• On-board GPS receivers
APTS2 Transit Fixed-Route Operations	Transit Center Fixed Route Operations	• Scheduling, blocking and runcutting • Monitor fleet locations and schedule adherence • Daily dispatch operations • Transfer connection protection
	Transit Garage Operations	• Vehicle assignment • Workforce management • Driver bidding and assignments in daily operations
APTS3 Demand Response Transit Operations	Transit Center Paratransit Operations	• Eligibility and reservations • Trip scheduling and developing run manifests • Monitor fleet locations and schedule adherence • Daily dispatch operations • Invoicing funding providers • Paying service providers
	Transit Garage Operations	• Service provider or vehicle assignment • Workforce management (not for service providers) • Driver assignments in daily operations (not for service providers)
	On-board Paratransit Operations	• Transmit run manifest to driver • Driver completes and transmits trip records
APTS4 Transit Passenger and Fare Management	Remote Transit Fare Management	• Kiosks, agency and retailer facilities where farecards and rider identification cards can be issued and revalued
	Transit Center Fare and Load Management	• Central system support for card and account balance management • Clearinghouse for allocating revenue between multiple transit agencies accepting a universal farecard
	On-board Transit Fare and Load Management	• Accepting a farecard or rider identification card on-board • Recording locations where cards are used
APTS5 Transit Security	Transit Center Security	• Monitoring driver covert alarm activation
	On-board Transit Security	• Driver covert alarm
APTS6 Transit Maintenance	Transit Garage Maintenance	• Automate scheduling and tracking of preventative maintenance and repairs • Fleet performance monitoring and analysis

Market Packages	Equipment Packages	Technology Elements
APTS7 Multi-modal Coordination	Transit Center Multimodal Coordination	• Coordinated paratransit trip scheduling with fixed route transit or across paratransit service area boundaries
APTS8 Transit Traveler Information	Personal Interactive Information Reception	• Riders receiving static transit information, next stop arrival estimates or trip itineraries using telephones, PCs and portable digital devices. Telephone access will use Interactive Voice Response (IVR) systems and automated voice/text notices, while PCs and portable device access will use websites and automatic email notices.
	Remote Transit Information Services	• Riders receiving next stop arrival estimates on variable signs at major transfer centers.
	Transit Center Information Services	• Develop real-time transit information and ready it for dissemination to riders.
	On-board Transit Information Services	• Use on-board location monitoring to trigger automated next stop announcements.

Figure 2.1
Architecture Diagram Mapping the ITS System Elements to the National Architecture Subsystems



2.6. Summary of FTA Policy on ITS Architecture Consistency and Its Effect on Iowa DOT Statewide Rural Transit ITS Deployment Plan[4]

On January 8, 2001 the Federal Transit Administration (FTA) published the **National ITS Architecture Policy on Transit Projects** in the Federal Register. The equivalent Federal Highway Administration Regulation on "Intelligent Transportation System Architecture and Standards," was also published. Both the Policy and Rule became effective on April 8, 2001. The Policy can be accessed from the FTA web site at http://www.fta.dot.gov/.

The new Policy and Rule contain provisions that help to foster integrated ITS deployment locally by requiring the development of regional ITS architectures. During a regional architecture's development, agencies that own and operate transportation systems cooperatively consider current and future needs to ensure that today's processes and projects are compatible with one another and with future ITS projects. The new Policy and Rule also require the use of a systems engineering analysis for ITS projects.

The Policy directs that:

- Regions currently implementing/operating **ITS projects** must have a **regional ITS architecture** in place in four years. Regions not currently implementing ITS projects must develop a regional ITS architecture within four years from the date their first ITS project advances to final design.
- ITS projects funded by the Highway Trust Fund and the Mass Transit Account must conform to a regional ITS Architecture.
- Prior to the adoption of a regional ITS architecture, "**Major ITS Projects**" not in Final Design by April 8, 2001 must include the development of a project level architecture that clearly reflects consistency with the National ITS Architecture.
- All ITS Projects not in Final Design by April 8, 2001 must be based upon a **Systems Engineering Analysis** on a scale commensurate with the project's scope and use USDOT adopted ITS standards as appropriate[5].
- No specific documentation is required. However, regions (FTA grantees) must be able to demonstrate compliance, account for Architecture maintenance and updating, and coordinate with Federal field offices.
- Monitoring compliance with the Policy will be in accordance with existing FTA oversight procedures used for all projects. FTA grantees will self-certify compliance. FTA is also providing additional ITS Oversight and Technical Assistance support to help address issues identified through the normal oversight activities.

Several important definitions and concepts (**bold above**) are also part of the Policy. These are briefly explained below.

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

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[4] Much of this section is adapted from draft guidance developed by FTA in October 2001, but never published.

[5] To date the USDOT has not adopted any ITS standards, and a formal rulemaking process will precede any such adoption.

ITS Project: "Any project that in whole or in part funds the acquisition of technologies or systems of technologies that provide or significantly contribute to the provision of one or more ITS User Services as defined in the National ITS Architecture".

Region: "The geographical area that identifies the boundaries of the regional ITS architecture and is defined by and based on the needs of the participating agencies and other stakeholders. A region can be specified at a metropolitan, Statewide, or corridor level. In metropolitan areas, a region should be no less than the boundaries of the metropolitan planning area".

Regional ITS Architecture: "A regional framework for ensuring institutional agreement and technical integration for the implementation of ITS projects or groups of projects". A regional ITS architecture shall include at a minimum:

- Description of the region
- Identification of the participating agencies and stakeholders
- An operational concept that identifies roles and responsibilities of stakeholders
- Any agreements required for operations
- System functional requirements (high level)
- Interface requirements and information exchanges with planned and existing systems and subsystems
- Identification of ITS standards supporting regional and national interoperability
- Sequence of projects required for implementation

A process and roles/responsibilities from maintaining the regional ITS architecture once it is developed must also be established.

Systems Engineering Analysis: "A structured process for arriving at a final design of a system". It evaluates a number of alternatives to meet the design objectives considering total life-cycle costs, technical merit, and relative value of each. A systems engineering analysis for ITS shall be on a scale commensurate with the project scope and at minimum shall include:

- How the project fits into the regional ITS architecture (or applicable portions of the National ITS Architecture)
- Identification of roles and responsibilities of participating agencies
- Requirements definition
- Analysis of alternative system configurations and technology options
- Procurement options
- Identification of applicable ITS standards and testing procedures
- Procedures and resources necessary for operations and management of the system

Major ITS Project: "Any ITS project that implements part of a regional ITS initiative that is multi-jurisdictional, multi-modal, or otherwise affects regional integration of ITS systems". As stated above, prior to the adoption of a regional ITS architecture all Major ITS Projects must include a Project ITS Architecture.

Project ITS Architecture: "A framework that identifies the institutional agreement and technical integration necessary to interface a major ITS project with other ITS projects and systems". The project level ITS architecture needs to be based on results of the systems engineering analysis, and should include at a minimum:

- A description of the scope of the ITS project
- An operational concept that identifies the roles and responsibilities of participating agencies and stakeholders in the operation and implementation of the ITS project
- Functional requirements of the ITS project
- Interface requirements and information exchanges between the ITS project and other planned and existing systems and subsystems
- Identification of applicable ITS standards

The Policy also states "**Development of the regional ITS architecture should be consistent with the transportation planning process for Statewide and Metropolitan Transportation Planning** (49 CFR Part 613 and 621)". All regional and project level ITS architectures must be consistent and included in the appropriate Transportation Plans, Transportation Improvement Programs, and Statewide Transportation Improvement Programs as is currently required under existing regulations.

A state can indeed be considered a region (see above definition), so the Iowa Statewide Transit ITS Architecture developed as Task 6 of this project could be considered a Regional ITS Architecture. However, it is not a true Regional ITS Architecture since it only includes transit and not any other stakeholders. Thus, it should be considered as a significant component of the Iowa Statewide ITS Architecture, which is pending approval by IDOT. In this case, the Iowa Statewide Transit ITS Architecture should comply with the FTA Policy, but it is not required to comply.

3.0 COMMUNICATIONS

Iowa Department of Transportation

TRANSIT ITS

Effective and efficient operation of transit systems relies on a communications infrastructure and vehicle-based communications technologies. Communications systems are used to transmit voice and data (both raw and processed) between transit vehicles and operations (e.g., dispatch) centers, and to transmit commands between operators and technologies (e.g., signal priority commands to traffic signal systems). Transit communications systems are comprised mostly of wireless technologies and applications. The two-way voice radio system used for fleet management and vehicle dispatching remains at the heart of most transit operations. However, other communication technologies are becoming common; for example, short-range data links for traffic signal priority, wayside communications, and signpost AVL. Mobile voice and data communication systems for bus transit include the use of analog, digital, and cellular digital packet data (CDPD).

Radio Communications systems are offered in various technologies and utilize various means to achieve the desired system functionality. There are significant differences in the basic physics and characteristics of different frequencies and why they are used for certain applications and not for others.

There are four fundamental questions that were used during the statewide communications assessment to define the research:

1. What are the communications resources available to the state's transit systems?
2. To what extent are the communication systems meeting needs and where are deficiencies?
3. What communications resources could be shared by the state's transit systems? Are there "surplus" communications resources?
4. What additional or new communications capabilities are needed to support the Statewide Transit ITS plan?

The opportunity to use existing state-owned radio communications infrastructure does not appear viable in the three to five year time frame. The design of these systems does not lend itself to the needs of most transit agencies. Moreover, Iowa DOT has neither the plans or the resources to upgrade the system to address transit needs. Transit systems do utilize existing infrastructure in many cases. For example, most small urban systems utilize the radio system used by other city departments.

3.1. Existing Transit Communication Systems in Iowa

The first step in preparing the type of communications assessment needed to support the Statewide Transit ITS plan project is a careful assessment of capabilities and needs of the transit agencies.

As part of the transit system assessments, information was collected on the communications systems and devices currently used by the state's transit systems. The state's transit agencies employ a variety of techniques to address the need for communications. Two-Way radio communication in the 150, 450, and 800 MHz frequency bands is most frequently used, although several systems use cellular communication. In addition, many systems use cellular as a supplement to their radio system for use when coverage is limited, or for confidential communications. For the most part, the state's transit systems are addressing their communications needs in an acceptable manner, i.e., managers rate the system adequate or better.

In nearly all the regional and small urban transit systems communications is limited to voice transmissions. The Ottumwa regional/small urban system is an exception, with both voice and data communications. Sioux City and Cedar Rapids also use data communications.

Several regional transit agencies do not have centralized communications systems because they are "brokered systems." In these cases the contract operator is responsible for providing communications between vehicles in the service area and a base station.

Although the communications function is being addressed by the systems currently in use, there has been some concern expressed regarding cost. The current arrangement does not allow for the least cost solution in some cases. For example, Region 4 recently acquired radio hardware with a total cost of about $120,000. This is a substantial project for an agency with an annual budget of only $1.3 million. In addition, ongoing charges for access to tower sites and frequencies and servicing typically exceed $10,000 annually for regional systems. Transit systems in small urban areas are typically able to use the radio communications system owned and operated by the city (usually the public works department). In this manner, the transit system avoids at least ongoing access-related costs.

3.2. Existing Communications Resources Within the State

Iowa Department of Transportation

The consultant team gathered preliminary information on the radio communications assets in place throughout the state that are being used by Iowa DOT and explored their short-term viability in support of transit ITS needs.

The Iowa DOT radio communications infrastructure is comprised of two systems operated and maintained by two entities within the Department, Highway Maintenance and Motor Vehicle Enforcement.

The Iowa DOT Highway Maintenance system includes approximately 99 tower sites and repeaters centrally located in every county in the state. Approximately 80% of the tower sites are located at or near the DOT office or garage in each county. The average tower height is 100 feet above ground level. The Iowa DOT's FCC radio communications licenses fall in the 150 – 160 MHz frequency range. Currently, these towers operate on a standalone, county by county basis without any existing capability to communicate across the state or between counties. The estimated monthly telecommunications costs to interconnect all of the towers throughout the state make it prohibitive to deploy a statewide integrated radio communications system for the Highway Maintenance division.

Iowa DOT has standardized on the 128 channel, ASTRO Spectra product line manufactured by Motorola, which incorporates the APCO 25 Communications Standard. ASTRO Spectra models operate in either voice or data modes within one radio, allowing the user to send and receive both types of information. The current technology can eventually migrate to an entirely digital system. The inventory of mobile radios is approximately 3,500. The inventory of handheld radios is approximately 1,000. These radios are currently being purchased for approximately $2,400 each, in volume. List price for this mobile radio with the 128 channel, Digital format and Conventional Software is $3,213, uninstalled.

Iowa DOT Motor Vehicle Enforcement system towers are located at or near Highway Scale sites. These radio towers reach as high as 180 feet above ground level.

The in-vehicle technology being used includes a laptop PC in each vehicle.

There exists a 4 wire data (virtual) circuit that is installed from each of these Motor Vehicle Enforcement tower sites to the nearest Point-of-Presence location for the Iowa Communications Network (ICN). Some of the locations are local high schools, while others may be community colleges. The current monthly charge from ICN to Iowa DOT is around $1,000 per month for each of these lines.

The Iowa DOT Motor Vehicle Enforcement radio system is divided into 6 districts. Districts 5 & 6 have digital voice capability. Districts 1, 2 & 4 have digital installed, but not operational at this point. District 3 should have digital radio capability by the summer of 2002. The digital radio system can communicate at a data rate of 9,600 baud.

Based on interviews with Iowa DOT communications staff, a typical regional transit system, if added to the state system, would not burden the DOT's Highway Maintenance radio system. It is also noted that Iowa DOT is favorable to the idea of other entities sharing their system. This type of relationship has the potential to generate revenue, cost-sharing and ultimately reduced expenditures to their existing system. It also provides a financial basis for upgrades.

Iowa Department of Public Safety/Iowa State Patrol

The consultant team gathered preliminary information on the radio communications assets in place throughout the state that were being used by IDPS and to ascertain the short-term viability in support of Transit ITS needs.

The IDPS is currently utilizing the same radios as Iowa DOT, Motorola. They currently have digital system in place, but are only utilizing the analog capabilities. They have approximately 28 towers with repeaters, while also utilizing a number of vehicle mounted repeaters. The IDPS/ISP has a number of entities sharing tower space at this time. An example is weather data gathering applications.

The ISP is currently working with Wireless Matrix Satellite Group out of Reston, Virginia as a component to the DataMax Law Enforcement software from Florida. This system allows data messages to be sent via satellite in four seconds or less to State Patrol vehicles virtually anywhere in the state. This is especially beneficial when checking for outstanding wants or warrants without tying up a voice or data channel on the radio system. Five Iowa vehicles were equipped with the satellite technology for testing and evaluation purposes. Testing has not been completed.

To the extent that it becomes feasible, the IDPS has expressed a willingness to share communications resources with other state entities. However, priority would always have to be given to IDPS communications.

Networking, Data and other IT Considerations

One of the most interesting issues researched was the Iowa Communications Network (ICN). The Iowa Communications Network is a statewide fiber backbone, designed primarily for distance education, but more than 80 percent of the traffic is something other than distance education. The network also handles long distance telephone traffic for state government, and administrative meetings are conducted using the network's two-way full-motion video capabilities. State law prohibits use by private parties, but some private users have been able to have access by partnering with educational institutions. Those institutions can reserve use of the network without justifying the purpose or explaining the nature of the use.

The Iowa Communications Network has at least one point of presence (POP) in every one of Iowa's 99 counties. Phased construction began on the ICN in 1991 and it is estimated that there are more than 600 existing points of presence throughout Iowa.

The Code of Iowa authorizes specific users. These include the Iowa National Guard, Iowa Public Television, libraries, State government agencies, community colleges, Regents institutions, private colleges and universities, all local school districts, area education agencies, hospitals and physician clinics, federal agencies, Iowa judicial and corrections systems, and the United States Postal Service.

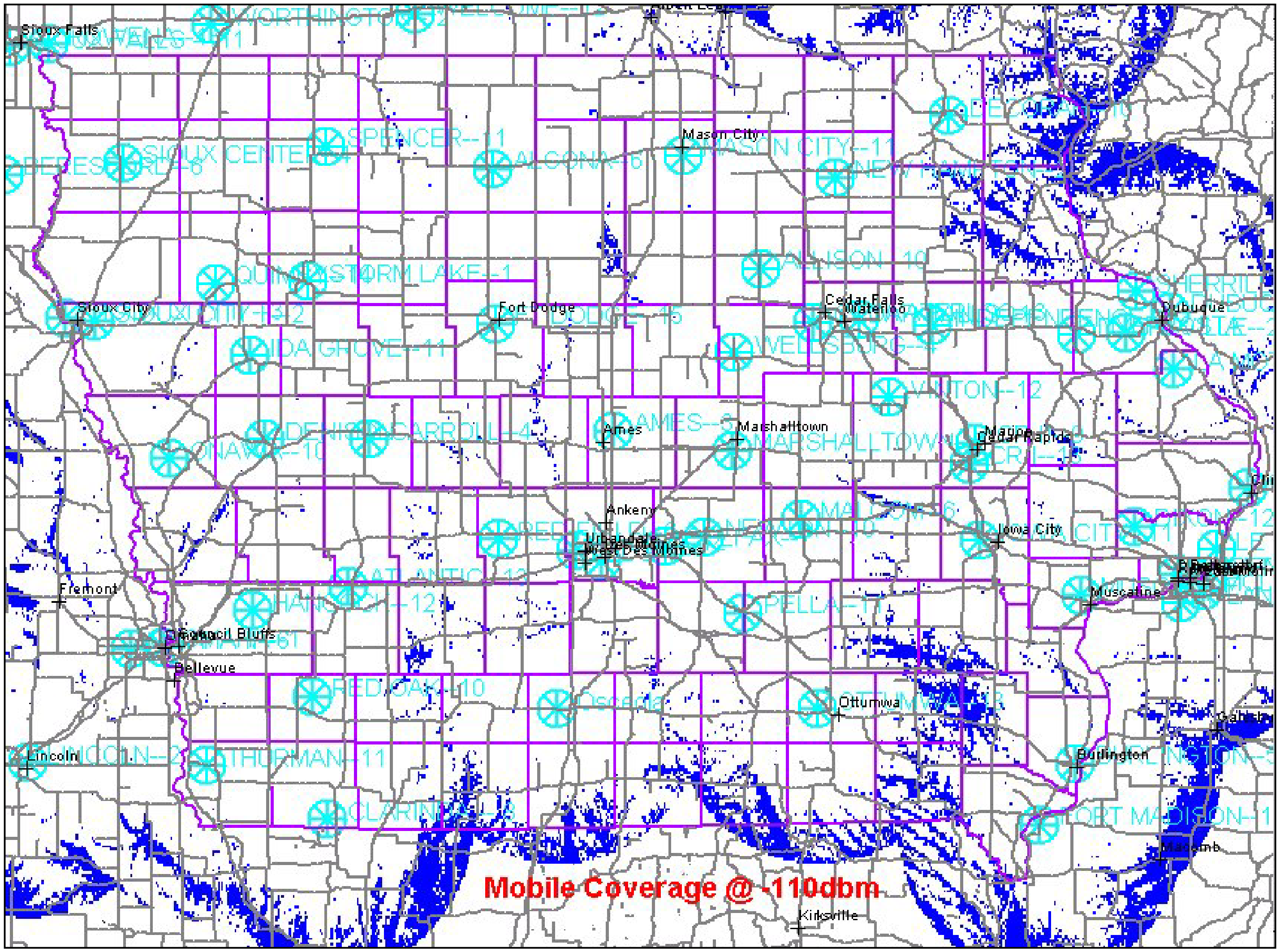
There does not appear to be any significant integration between the ICN and any of the State owned radio communications networks. Assuming available bandwidth, and, assuming an economically viable means to connect the towers and the nearest ICN point of presence, the possibilities of advanced, integrated statewide communications becomes a real potential.

Private Third-Party Providers in Iowa

Racom, a privately held company headquartered in Marshalltown, Iowa, is one such third-party provider. The firm operates a large 800 MHz trunked digital wireless network throughout much of the State of Iowa. The company's core business consists of wireless voice and data services for public safety, utility, and industrial customers.

The Racom backbone network consists of M/A Comm Wireless EDACS system. Racom has more than 70 different tower locations throughout Iowa and neighboring states. Figure 3.1 shows the Racom tower sites as well as the EDACS coverage area.

Figure 3.1
Racom Tower Sites and EDACS Coverage Area



3.3. Conclusions on Communications

What are the communications resources available to the state's transit systems?

The State of Iowa has a multitude of communications resources available including the ICN's fiber optic network, non-networked radio communications resources from Iowa DOT and Iowa DPS, as well as a number of private communications providers including local telephone providers, cellular telephone providers, Nextel's Communications network and Racom's statewide EDACS radio network.

To what extent are the communication systems meeting needs and where are deficiencies?

For the most part communications systems employed by the state's regional and small urban systems are meeting their own needs. Some of the large regional systems experience limitations in coverage. The fragmentation of technology limits direct coordination through the communications system. It also limits the type of ITS technologies that can be deployed, such as AVL. Although communications are being addressed by the systems currently in use, there has been some concern expressed about cost. The current arrangement does not allow for the least cost solution in some cases.

What communications resources could be shared by the state's transit systems? Are there "surplus" communications resources?

The existing communications systems are designed for their individual intended uses and are not suitable for transit applications in most cases, as presently configured and deployed, with the exception of voice only capability in each county. This is especially true for the regional systems that have extensive service areas.

Surplus capacity does exist, but availability and transit needs would have to be determined on a case-by-case basis.

In order to utilize any surplus communications capacity transit systems will face financial, legal and administrative issues. These issues represent obstacles that can be overcome through cooperation among transit systems and the communication systems owners and managers.

Iowa DOT staff representatives have expressed willingness to work with statewide transit interests on a shared use demonstration project.

What additional or new communications capabilities are needed to support the Statewide Transit ITS plan?

The ability to transmit and receive data is a requirement for some transit operations applications. Generally, the need to provide for data communications to support ITS applications such as Mobile Data Terminals (MDT's) and AVL is expected to be the greatest challenge. While voice and data can use the same channel in conventional radio systems, most transit agencies provide a separate channel for data to avoid complications arising from the joint use of a channel. Most regional and small urban systems have only one channel currently available.

Another consideration is cost. Experience with commercial communication providers has shown access charges increase significantly (e.g., double) when data communications is included. In addition, there is a cost associated with enabling radio equipment for data transmission.

There are significant communications resources currently being used and available throughout the State of Iowa. For all practical purposes, they are standalone applications. Based upon the needs of statewide ITS, IDOT, IDPS and other county governmental entities, there appears to be a long range opportunity to combine and integrate a number of user bodies' needs into a truly interoperable statewide system. However, much further study and evaluation of specific needs would be required.

3.4. Future State Communication System Enhancements

Steve Gray of the Iowa DOT briefly discussed an alternative radio communications technology with the Steering Committee during a meeting in Ames on September 18, 2002. The information below is intended to provide brief commentary on the applicability to the Statewide Transit Intelligent Transportation Systems Deployment Plan.

The Iowa DOT has acknowledged that their radio communications technology and infrastructure are in need of upgrade and does not appear to support voice communications from county to county, nor, in its current form, does it support any of the required data communications needs of Transit ITS programs. It can, however, support additional users whose requirements do not exceed having to communicate with up to 20 vehicles within a specific geographic region, e.g. any given Iowa county.

The costs to upgrade Iowa DOT's radio communication systems to support communications between counties and to enable data communications could cost up to $200 million according to responses from Iowa DOT communications personnel. Given that there is no budget available, the likelihood of accomplishing this upgrade in the near term is doubtful. Therefore, Iowa DOT has begun an investigation into other upgrade opportunities.

According to Steve Gray, the system currently being evaluated by the Iowa DOT is based upon technology developed and provided by JPS Communications, Inc. of Raleigh, North Carolina. The hardware and software developed by JPS is an outgrowth of the Air Force's Scope Command, a computerized radio system that links pilots to the service's bases around the world. SCOPE, an acronym for System Capable of Planned Expansion, is designed to provide seamless end-to-end voice over IP (VoIP) communications connectivity comparable to commercial telephone systems and integrating radio communications with telecommunications and networking technologies. Simply put, the JPS technology would digitize voice signals and transmit them over the digital computer network to be retransmitted by a radio communications repeater at another location anywhere on the network.

This technology addresses the need for communications interoperability - defined as the ability for two or more parties (e.g., two different agencies) to exchange information, when and where needed, even when disparate communications systems are involved.

The Iowa DOT has radio communications repeaters and towers located at most every DOT facility in every county throughout the state. They also have an ICN provided computer network connection at each of these facilities. The basic infrastructure of having a network connection physically located near a radio communications repeater is the basis for considering the JPS technology for their hardware and software. If the JPS technology were implemented in this environment, then the network connection would act as a communications path for converted radio voice communications. This would require the installation of JPS hardware and software at each tower location, the installation of additional, or new, repeater technology at each tower location as well as the changing out of all DOT radios.

Implementation of the JPS technology and securing connectivity to a state owned computer network could, potentially, provide similar capabilities to the existing radio communications network in place and being offered by Racom of Marshalltown, Iowa. This could enable voice communications between Iowa DOT and Transit entities in any given county. This could furthermore enable communications from one county to any other county in the state. These capabilities would require that all of the changes discussed before, as well as upgrading in each county that requires such capability. It would also require that Iowa Transit agencies utilize similar if not identical radios as the state.

Costs associated with such a potential are not available. Regarding the timeframe, there is no legislation, or state authorized programs supporting such a change. However, the idea does have merit, both for Iowa DOT and other radio communications users, and should be investigated further.

4.0
COSTS AND BENEFITS

Iowa Department of Transportation

TRANSIT ITS

This section evaluates the potential benefits and costs associated with transit ITS applications, and is the basis, in part, for the conclusions and recommendations relative to deployment.

The benefits must be related to the needs and expectations of transit managers in Iowa. Subsection 4.1 is a summary of these needs, expectations and project objectives, and Subsection 4.2 summarizes how ITS applications can be a benefit in addressing these needs and objectives. Subsection 4.3 includes two case studies illustrating how transit agencies can benefit from ITS applications.

Subsection 4.3 is a summary of deployment costs for transit ITS.

4.1. Transit System Needs and Objectives

The following list of expectations emerged from the interviews with transit system managers during the site visits conducted in Phase IA:

- Better control over drivers and vehicles, especially in systems with very large service areas with decentralized operations.
- Reduction in the effort required to produce documentation for reimbursements.
- Improved safety for drivers and customers in remote areas
- Generally improved transit service (e.g., reliability)
- Improved efficiency in transit service delivery
- Improved data accuracy and flows to support management decisions

By far, the first two expectations are the most important among the managers. Control over operations in the large regional systems is difficult, and often informal in nature. There is significant reliance on individual drivers, and operating personnel are frequently volunteers, or their transit duties are secondary to other responsibilities.

Mangers in most regional systems spend an inordinate amount of time preparing documentation to support reimbursements, often manually compiling large amounts of trip data. Time spent on these tasks is time taken away from other managerial duties.

Most managers indicate awareness that the benefits of technology are often intangible, and recognize that cost reduction may not follow from implementation.

With this information in hand, the Steering Committee and consultant team developed goals and objectives for deploying transit ITS throughout Iowa. These goals are shown in Table 4.1 on the following page.

Table 4.1
Objectives for Deploying Transit ITS

Goals	Objectives/Evaluation Criteria
Improve operational and administrative efficiencies, system performance and information for operations	• Increase automation of administrative functions (e.g., third-party billing) • Increase automation of operations and management functions, including vehicle maintenance. • Reduce travel time variability (including reducing service delays and average travel time, and increasing average vehicle speed • Increase employee satisfaction • Provide data management capabilities • Provide data communication system • Increase productivity (passengers per vehicle hour) • Increase number of trips provided • Increase ridership • Increase number of passenger trips per vehicle mile
Improve transit and paratransit services/enhance mobility	• Increase inter-regional service coordination • Increase intra-regional service coordination • Monitor vehicle location more effectively • Increase operating hours
Reduce operational and administrative costs	• Reduce cost per passenger-trip or passenger-mile • Reduce cost per vehicle-hour • Shift trips from paratransit to fixed-route service • More accurate and timely billing • Reduce administrative costs
Improve safety and security of passengers and drivers	• Monitor vehicle location more effectively • Provide silent alarm feature in vehicles • Provide data communication system • Decreased response time to incidents
Improve customer service	• Improve reliability of service • Reduce travel time and service delays • Increase customer satisfaction • Reduce time required to schedule a trip • Reduce customer wait time prior to a trip • Reduce number of customer complaints
Improve integration with other technologies	• Provide information to Iowa 511 system • Exchange information with traffic management centers • Use Weatherview information

The Steering Committee “voted” to rank the goals, indicating the relative importance of each of the goals. The results of the ranking are shown in Table 4.2.

Table 4.2
Evaluation Criteria

Ranking	Goals	No. Votes
1	Improve operational and administrative efficiencies, system performance, and information for operations	121
2	Reduce operational and administrative costs	49
3	Improve customer service	48
4	Improve safety and security of passengers and drivers	35
5	Improve transit and paratransit services/enhance mobility	34
6	Improve integration with other technologies	24

Table 4.3 shows how each of the available technologies addresses the specific objectives. Each technology was ranked on a scale of 1 to 10 for its ability to address the objective (10 being the highest).

Table 4.3
Effectiveness of Technology in Achieving Goals

Goal	Vehicle maintenance software	Computer-assisted scheduling software	Data communication/MDTs	Fully automated scheduling software	AVL	Electronic Fare systems	User Info. Systems
Improve operational and administrative efficiencies, system performance, and information for operations	3	6	9	9	8	4	1
Reduce operational and administrative costs	3	5	8	8	6	3	1
Improve customer service	2	4	8	8	7	1	3
Improve safety and security of passengers and drivers	2	1	9	1	10	1	1
Improve transit and paratransit services/enhance mobility	2	6	5	8	4	1	2
Improve integration with other technologies	2	5	10	8	9	1	5

Table 4.3 shows that the scheduling, data communications and AVL applications are most effective for the Iowa transit systems, followed by vehicle maintenance and electronic fare systems. User information systems do not address the operational objectives and needs, and are therefore not effective in this context.

4.2. ITS Application Benefits

ITS applications are able to address the Iowa transit objectives and return benefits, both tangible and intangible. The following is a summary of these benefits.

Vehicle Maintenance

Software programs can help automate vehicle maintenance tracking and analysis. Instead of recording maintenance activities in paper files, details can be recorded in a computer database. By building on the capabilities of commercial database management software, fleet maintenance software programs have been made easy to use with on-screen input forms. The database can also be used to periodically generate reports such as work orders, purchase orders, and reports for tracking and analyzing vehicle or staff performance indicators.

Vehicle maintenance programs can help reduce vehicle maintenance costs and increase the life of fleet vehicles. The degree these savings can be realized is dependent upon the state of the maintenance program prior to use of the system.

Scheduling Software

The term scheduling software is used to refer to Transit Operations Software Management software that includes GIS, reservations and scheduling software, Computer-Aided Dispatch (CAD) and report writing. Generally, the need for these management related applications increases as the size and complexity of the transit operation increases.

Reservations and scheduling software can increase the productivity (trips per hour) of a paratransit operation by 2% to 5% leading to reductions in operating cost. Some transit systems have reported substantially greater improvements in productivity. GIS is a tool that can be used to contribute to this increased efficiency through reconfiguration of routes. Computer Aided Dispatch (CAD) software helps the dispatcher identify and assess the feasible alternatives when operational problems occur, and keeps a comprehensive record of any changes that are made. This results in improved service reliability and improved customer service. The reporting feature can automate the compilation reporting of data required for reimbursements and other reports, reducing manual preparation.

Data Communications and Mobile Data Terminals (MDTs)

MDTs support text messaging between drivers and dispatch. In a paratransit operation, text messaging can help improve efficiency by transmitting the trip manifest for the run directly to the vehicle (i.e., rather than being printed off for the driver as a paper manifest), as well as any real-time manifest changes during daily operations. The driver can use the MDT to indicate the completion of each pick-up and drop-off, and this information can be transmitted back to dispatch in real-time. MDTs can enable further enhancements to daily operations through integration with computer-aided dispatch (CAD) and automatic vehicle location (AVL) software.

Two additional types of text messages that MDTs can support are alarms and vehicle maintenance monitoring. The MDTs can provide a silent alarm, which is unobtrusively mounted switch near the driver. This alarm, when activated, will covertly notify dispatch of an emergency situation. Vehicle maintenance monitoring circuits can be wired into MDT relays, that can be configured to send a text message to dispatch whenever a circuit detects a beyond threshold condition (e.g., coolant temperature, oil level).

Data communications can significantly enhance management's control over transit operations, vehicles and drivers. This is especially important in larger service areas, and where field supervisors are not available. The result is greater reliability and accountability, and potentially greater efficiency. Customer service can be improved as a result of the ability to better service customers requesting same day trips.

Automatic Vehicle Location (AVL)

Even with CAD software support, the dispatcher must still be aware of vehicle locations. AVL software operating at a central dispatch location receives periodic location reports from each vehicle in the field and then updates the vehicle locations displayed on a GIS map (using symbols representing each vehicle). This time-stamped location data can also provide dispatchers with schedule adherence information by exception and can lead to increased reliability and productivity.

Electronic Fare Payment Systems

Machine-readable fare cards are can be used to carry fare payment or rider identification information. Applications can provide fixed data such as a rider identification number or updateable data such as the end date for a period pass, the remaining number of prepaid rides or the remaining prepaid cash fares balance. Electronic Fare Payment systems used in conjunction with MDT's and Transit Management software can form an integrated system to automate many of the administrative tasks involved with reporting and invoicing. These systems can be particularly beneficial to paratransit systems that typically have a higher level of reporting requirements to support funding sources. Electronic Fare Payment systems can also be used for trip verification.

User Information

Technology can enhance both the quantity and quality of the information available to the public. Applications include a variety of web-based systems that allow both static information and interactive systems for use in trip planning. Other applications include the installation of computer terminals in kiosk format at high-traffic public locations. Variable message signs can be installed at bus stop locations to provide both scheduled and real- time information to the public.

Because much of the information exchange between transit system managers and their customers is by telephone, particularly for paratransit operations, benefits can be secured through advanced telephone systems. Interactive Voice Response (IVR) systems may be useful for the larger transit systems that experience very high call volumes. At a minimum, all transit systems should have telephone voice mail or other recording systems that allow customers to communicate with the transit systems at all times of the day.

The benefits of these systems include enhanced customer service, reduced administrative costs and increased ridership where the transit market includes discretionary (i.e., choice) riders.

4.3. ITS Case Studies – Benefits Realized

There have been a number of successful deployments of ITS at transit agencies specializing in the delivery of paratransit. This section includes two case studies of successful deployments discussing the benefits derived from the ITS applications. It is intended that these case studies illustrate the potential that exists in Iowa for paratransit systems to improve efficiency and enhance service delivery through the use of advanced technology. As explained in the case studies, the benefits may be intangible in some cases, but are nonetheless real and of value to transit agencies.

Outreach

Outreach is a nonprofit paratransit broker in Santa Clara, California that contracts with several local van and auto-fleet companies to provide more than 1,700 rides a day over a 324 square-mile area. In the mid-nineties, it was providing service for more than 7,100 passengers on nearly 379,000 trips a year.

With such high demand for its service and very limited resources, it was no surprise that when the Americans with Disabilities Act (ADA) passed in 1990, requiring communities with fixed route service to provide the same level of paratransit service, Outreach realized that this could be achieved only through the use of ITS technology. So in July 1993, Outreach submitted a proposal to upgrade its equipment and subsequently received $750,000 grant from the state and U.S. DOT.

Outreach established a plan of three phases to be implemented over the next three years. The first phase, started in the spring of 1994, was the acquisition of a geographic database. The geographic database stores and disseminates route planning, guidance, and positioning data. The system provides dispatchers with city and street names, block-by-block addresses ranges, speed limits, turn restrictions, and information on major facilities.

The second phase, started in May 1994, was the implementation of automated scheduling and routing software. The software helped Outreach staff to schedule vehicles based on several criteria, such as passenger origins and destinations, loading times, disabled clients' needs, and preset daily routes. The software also determines fare rates.

The third phase, acquisition of a global positioning system (GPS)-based automatic vehicle location (AVL) system, was initiated in November 1995. The system integrates mobile data terminals (MDTs) and mobile radios to support dispatch assignments and intermodal connections to fixed-route transportation. Through the use of two-way messaging, drivers are kept up-to-date on their workload. In June 1996, the project was complete.

The results of ITS integration were dramatic. A study conducted by the University of California-Berkley found that in 1996, Outreach increased shared passenger rides from 38% to 55% allowing it to cut back its fleet from 200 to 130 vehicles and reducing the cost per passenger mile for a van trip from $4.88 to $3.72. Reducing the number of vehicles also helped Outreach reduce its impact on congestion and pollution.

Outreach's annual savings during the first year of operation of the automated scheduling system was $488,325. In addition, the use of AVL increased efficiencies through real-time electronic communication with remote vendor dispatchers and drivers in vehicles; and, real-time data from the AVL system is used to support daily operations through analysis of schedule adherence, on-time performance, improve vehicle productivity in general and in terms of real-time schedule changes.

One element that makes the system so unusual is how well it connects paratransit riders with regular transit services. Trip requests for participating clients are automatically analyzed to determine if fixed-route and paratransit services could be combined. The system would automatically schedule paratransit legs so that the intermodal connection is successful. Vehicle schedule adherence is monitored real time on the day of service to determine if the scheduled intermodal connection is still valid.

Winston-Salem

Winston-Salem Transit Authority (WSTA), through its Trans-Aid division, provides demand responsive transportation services in the greater Winston-Salem and Forsyth County area in North Carolina. Trans-AID of Forsyth County operates dial-a-ride paratransit services for certain authorized residents of Winston-Salem and surrounding Forsyth County. In 1994, Trans-Aid was providing 120,000 passenger trips per year on a fleet of 19 small buses. Hours of operation are 6 a.m. to 12 a.m., Monday through Friday, with abbreviated service on Saturday.

In 1993, WSTA was selected as one of the Federal Transit Administration's 15 demonstration sites for Advanced Public Transportation Systems (APTS) or transit intelligent transportation systems (ITS). The goal of the Winston-Salem Mobility Manager project was to provide a single source of information about local travel and mobility options while coordinating operations, trip reservations, and financial transactions using ITS technologies.

In August of 1994, WSTA began implementation of Phase I of the Winston-Salem Mobility Manger project. WSTA selected its paratransit system, Trans AID, as the test department for Phase I. The goal of Phase I was to implement Computer Aided Dispatching and Scheduling (CADS) software for the entire Trans-AID system. Mobile Data Terminals (MDTs), Automatic Vehicle Location (AVL) and contactless Smart Card Readers were installed in three of Trans-AID's vehicles and integrated with the CADS system. A CADS remote site was set up at the Department of Social Services. Also, parallel research and independently funded projects to evaluate the impacts of the different ITS technologies was conducted. Phase I was successfully completed in June 1995.

With the implementation of Phase I, Trans-Aid showed an increase in ridership on its rural routes (17 to 40 passengers per day), and a 12% increase in its urban ridership. Paratransit ridership increased 17.5%, while passenger wait times were reduced by 50%. And even though vehicle-miles increased by 8.5%, Trans-Aid still managed a 5.6% reduction in vehicle-hours. Furthermore, while total operating costs for the Trans-Aid DRT operations increased (because of the increased service), their operating cost per vehicle-mile dropped by 8.5% and their operating cost per passenger trip dropped by 2.4%.

4.4. Technology Costs

The cost of these applications varies significantly with a number of factors, including the capabilities desired in the application. The following paragraphs provide general information on the cost of ITS applications that may be deployed in Iowa's small urban and regional transit systems.

Vehicle Maintenance Software

This application ranges in cost from a few thousand dollars for simple packages suitable for most Iowa transit systems to several hundred thousand dollars for sophisticated systems for large fleets. The lower end product is judged to be applicable for Iowa rural and small urban systems. The cost is likely to vary somewhat with fleet size. It is estimated that all systems could be provided the same software package, including installation and training, for less than $100,000.

Scheduling Software

The costs of scheduling systems vary significantly with the capabilities of the package and the vendor. For the cost analysis, a commercial package was assumed with client database management, trip reservation, manifest preparation and reporting capabilities. The "low-end" application would be "computer assisted scheduling" only. The "high-end" system would have fully automated scheduling and CAD capabilities and allow for integration with MDTs and AVL. It was also assumed that each installation would be independent, with a server and required hardware and software.

The initial cost for a low-end installation, including hardware and training was estimated at $72,000 for smaller transit systems. The cost of a high-end application for larger transit systems was estimated at $100,000 to $130,000 inclusive of training and hardware.

Software systems can be purchased from vendors with limited experience in the transit industry for significantly less cost. These products may not have all capabilities, and may not be supported to the level of more "mature" products. Several Iowa transit systems are using this type of product successfully.

Another option involves having multiple users on one system. Various schemes to share the base software among a number of individual transit systems can result in significantly lower costs per installation. Potential cost savings for these factors were not included in the cost estimates, however some vendors report cost reduction in the range of 25% to 30%.

Data Communications

The cost for real time data communications includes both central dispatch and mobile hardware, and the cost of providing the communications service. It was assumed that one data channel (for RF service) or a separate service (e.g., CDPD) would be used for data communications. The cost of data communications is very dependant on the fleet size with initial costs of $500,000 or more for the larger transit systems, including MDTs and communications service.

An alternate to real time data communications is to store data during the service day for uploading later. Data can be stored in an on-board device that can be transferred to a cradle in the facility, or uploaded from a remote location. The cost is substantially less because special communication provisions are not required – phone lines or Internet service would be used. This type of application for a large regional system, referred to as delayed data communications, could cost in the range of $50,000 to $75,000, inclusive of planning/design, software and hardware. The cost for this alternative was not included in the utility cost analysis in Section 5, but is included in the development of the deployment plan recommendations in Section 7.

Automatic Vehicle Location

The cost for AVL includes both hardware for mobile units and central system software. The cost estimates assume the presence of a data communications system capable of transmitting data in real time. The total initial cost is estimated at $175,000 to $200,000 for a large regional system. This cost includes GPS antenna and receiver, network hardware and software, AVL software, central server, and AVL workstations.

Operating and Maintenance Costs

All ITS applications have ongoing operating and maintenance costs. Operating costs include annual staff salaries and benefits, rent and maintenance of facilities, general overhead expenses, and shared costs with other transit ITS projects. Maintenance costs include annual repair, upgrade, and support costs for hardware, software, and operational facilities. Since the exact operating and maintenance costs are not known for most transit ITS systems, these costs are estimated as a percentage of the capital costs, using 10% and 8%, respectively. These estimates have been used in numerous transit ITS cost-benefit analyses, including those conducted in Chicago, Fort Worth, TX and York, PA.

5.0
ITS PROJECT EVALUATION

Iowa Department of Transportation

TRANSIT ITS

This section presents the evaluation criteria and process that were used to determine the priorities for transit ITS deployment throughout Iowa. This section also summarizes the assessment of the estimated costs and potential benefits associated with 22 transit ITS projects covering the rural, small urban and regional transit systems. Evaluating the costs and benefits provides additional information for determining which projects best meet the Iowa DOT's goals.

5.1. Goals and Objectives

Based on the results of the tasks performed in Phase IA of the project, the Steering Committee and consultant team developed goals and objectives for deploying transit ITS throughout Iowa. These goals are shown below in Table 5.1.

Table 5.1
Goals and Objectives for Deploying Transit ITS

Goals	Objectives/Evaluation Criteria
Improve operational and administrative efficiencies, system performance and information for operations	• Increase automation of administrative functions (e.g., third-party billing) • Increase automation of operations and management functions, including vehicle maintenance. • Reduce travel time variability (including reducing service delays and average travel time, and increasing average vehicle speed • Increase employee satisfaction • Provide data management capabilities • Provide data communication system • Increase productivity (passengers per vehicle hour) • Increase number of trips provided • Increase ridership • Increase number of passenger trips per vehicle mile
Improve transit and paratransit services/enhance mobility	• Increase inter-regional service coordination • Increase intra-regional service coordination • Monitor vehicle location more effectively • Increase operating hours
Reduce operational and administrative costs	• Reduce cost per passenger-trip or passenger-mile • Reduce cost per vehicle-hour • Shift trips from paratransit to fixed-route service • More accurate and timely billing • Reduce administrative costs

Goals	Objectives/Evaluation Criteria
Improve safety and security of passengers and drivers	• Monitor vehicle location more effectively • Provide silent alarm feature in vehicles • Provide data communication system • Decrease response time to incidents
Improve customer service	• Improve reliability of service • Reduce travel time and service delays • Increase customer satisfaction • Reduce time required to schedule a trip • Reduce customer wait time prior to a trip • Reduce number of customer complaints
Improve integration with other technologies	• Provide information to Iowa 511 system • Exchange information with traffic management centers • Use Weatherview information

Because evaluation criteria should represent what is expected to result from the deployment of transit ITS, it was determined that the objectives are effective evaluation criteria. The evaluation criteria that are being used to prioritize transit ITS projects for deployment were adopted by the Technical Committee and the Committee "voted" to rank the goals. The results of the ranking are shown in Table 5.2.

Table 5.2
Final Evaluation Criteria

Ranking	Goals	No. Votes
1	Improve operational and administrative efficiencies, system performance, and information for operations	121
2	Reduce operational and administrative costs	49
3	Improve customer service	48
4	Improve safety and security of passengers and drivers	35
5	Improve transit and paratransit services/enhance mobility	34
6	Improve integration with other technologies	24

These goals are used for evaluation criteria in the utility-costs analysis.

5.2. Utility-Cost Analysis

Because the benefits of deploying transit ITS in rural and small urban systems in Iowa are difficult to accurately estimate, and evaluation criteria have been developed to reflect ITS benefits, a utility-cost analysis approach was used to determine the order in which transit ITS projects should be deployed.

Utility-cost analysis requires, in the absence of monetary values of benefits, that weighted indices of effectiveness be created. These indices, registering the utility of ITS actions to meet goals, objectives, and/or evaluation criteria, are created using subjective reasoning, often based on consensus input from informed and interested parties. Utility criteria can account for how well ITS technologies address the needs of the provider, customers and/or positive externalities. In the case of this project, the evaluation criteria/goals that were developed for Task 7 were to be used as the weighted indices of effectiveness.

The objective of the utility-cost analysis is to determine and evaluate available information for transit ITS projects for rural, small urban and regional transit systems in Iowa. The project team used this data to facilitate rough comparisons among the projects. Comparisons, however, must take into account a variety of factors. The fact that cost information was determined generally (based on the costs presented in Task 5) means that variables such as the detailed costs associated with a particular agency, and variations in potential benefits could lead to inconsistencies in the information. For example, in all cases, the project team determined generalized capital, and operating and maintenance costs, which did not include detailed, line item budgets for each transit agency's planning, development, design, and start-up costs. Benefits data was even less detailed, not quantifiable, and more variable than the cost data.

Nevertheless, the utility-cost analysis gives Iowa DOT stakeholders a general illustration of expected project costs and anticipated project benefits.

The project team calculated a single cost figure for each of the 22 projects. Three types of costs were included for each project:

- Capital and other one-time costs;
- Annual operating costs (estimated at 10% of capital costs); and
- Annual maintenance costs (estimated at 8% of capital costs).

Capital costs include one-time expenditures for hardware, software, and services to implement and deploy a project. Where available, non-recurring expenditures for planning, design and engineering, system integration and other one-time start-up costs were also included as capital costs.

All projects were assumed to have a five-year life cycle. The capital and other one-time costs were also assumed to be in present value dollars. This assumption eliminated the difficult, time-consuming, and often infeasible task of determining the present value of funds that had been expended at different times and/or would be spent in the future. The assumption of the five-year project life cycle was also needed for consistency with the net present value (NPV) calculations described below.

Annual operating costs include recurring expenditures for items such as staff salaries and benefits, rent and facility maintenance, communications charges, and other overhead expenses. Maintenance costs include annual repair, upgrade, and support costs for hardware, software, and operational facilities. The project team estimated the operating and maintenance costs as a percentage of the capital costs, using 10% and 8% respectively.

An NPV was calculated for both operating and maintenance costs to transform them into numbers that could be added to the total capital costs. The discounting period for the NPV calculations was set at the same five-years as the project life cycle. The NPV calculations were made using a discount rate of 6%, consistent with federal standards for life cycle costing of federally-funded projects.[6] Total base and present value costs are provided in Table 5.6 for each of the 22 projects assessed.

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6 "Guidelines and Discount Rates for Benefit-Cost Analyses of Federal Programs." Office of Management and Budget: Circular No. A-94 (revised January 2000), Transmittal Memorandum No. 64; October, 1992.

The six evaluation criteria (see Table 5.1) for the transit ITS systems that are being considered for deployment in Iowa represent the needed goals for the utility-cost analysis. In this step, each of these goals is assigned a weight from 1 through 10, with 10 being the most important. The goals are independent of the technologies being considered.

The weights were determined as follows. Since the voting process yielded a significant difference among the goals, weights were assigned to these goals that were representative of the importance of each goal. The importance was reflected in the number of votes that each goal received. Table 5.3 shows the weighting for each goal.

Table 5.3
Weights of Goals

Goal	No. Votes	% Total Votes	Final Weight
Improve operational and administrative efficiencies, system performance, and information for operations	121	39	10
Reduce operational and administrative costs	49	16	4
Improve customer service	48	15	4
Improve safety and security of passengers and drivers	35	11	3
Improve transit and paratransit services/enhance mobility	34	11	3
Improve integration with other technologies	24	8	2
TOTAL	311	100	

The next step in the utility-cost analysis is to assess each transit ITS project in terms of its effectiveness in meeting each goal. In this case, a 1-10 scale was used, with 10 being most effective. These ratings (and the scale) were defined based upon the consultant team's extensive experience in transit ITS. The effectiveness ratings are shown in Table 5.4.

Table 5.4
Effectiveness of Technology in Achieving Goals

Goal	Vehicle Maintenance Software	Computer-assisted scheduling software	Data communication/MDTs	Fully automated scheduling software	AVL
Improve operational and administrative efficiencies, system performance, and information for operations	3	6	9	9	8
Reduce operational and administrative costs	3	5	8	8	6
Improve customer service	2	4	8	8	7
Improve safety and security of passengers and drivers	2	1	9	1	10
Improve transit and paratransit services/enhance mobility	2	6	5	8	4
Improve integration with other technologies	2	5	10	8	9

Next, the total utility was calculated (see Table 5.5). This part of the analysis is pure arithmetic: multiply the effectiveness factor from Table 5.4 (showing how well an ITS technology addresses a goal) by the weight of that goal from Table 5.3. Then, for each technology, sum all the utilities to determine the overall utility for that technology.

Table 5.5 shows that data communication, both computer-assisted and fully automated scheduling/dispatching software, MDTs and AVL have the highest overall utility in Iowa, meaning that they will yield the most significant benefits. Their overall utilities are very similar. Vehicle maintenance software ranks much lower in terms of the effectives in meeting the aforementioned goals.

Table 5.5
Total Utility

Goal	Vehicle maintenance software	Computer-assisted scheduling software	Data communication/ MDTs	Fully automated scheduling software	AVL
Improve operational and administrative efficiencies, system performance, and information for operations	30	60	90	90	80
Reduce operational and administrative costs	12	20	32	32	24
Improve customer service	8	16	32	32	28
Improve safety and security of passengers and drivers	6	3	27	3	30
Improve transit and paratransit services/enhance mobility	6	18	15	24	12
Improve integration with other technologies	4	10	20	16	18
TOTAL UTILITY	66	127	216	197	192

This section includes the general costs for each of the technologies. Table 5.6 shows the total costs for each technology being recommended for deployment and the average cost per agency.

Table 5.6
Technology Costs

System	Vehicle maintenance software	Computer-assisted scheduling software	Data communication & MDTs	Fully automated scheduling software	AVL
Mason City Transit	$4,220	$121,428			
Burlington Urban System	$4,220	$121,428			
Clinton	$4,220	$121,428			
Marshalltown MMT	$4,220	$121,428			
Muscatine Muscabus	$4,220	$121,428			
Region 11 HIRTA	$9,143	$180,174	$1,062,042		
Fort Dodge DART	$6,330	$121,428	$268,562		
Region 2 North Iowa RTA	$9,143	$180,174	$1,013,212		
Region 10 East Central Iowa	$6,330		$817,894	$158,592	$282,580
Region 1 NRTS	$6,330		$537,124	$158,592	
Region 5 MIDAS	$6,330		$512,710	$158,592	$282,580
Region 6 Peoplerides	$4,220		$219,733	$139,010	
Region 7 Iowa Northland	$4,220		$292,977	$139,010	
Region 8 RTA	$4,220		$390,636	$158,592	
Region 9 River Bend Transit	$6,330		$708,028	$178,174	$282,580
Region 12 Western Iowa	$6,330		$805,687	$178,174	
Region 13 SWITA	$6,330		$683,613	$178,174	
Region 14 Southern Iowa	$6,330		$476,088	$158,592	
Region 15 Ottumwa/10-15	$6,330		$610,369	$158,592	$282,580
Region 16 Southeast Iowa	$4,220		$280,770	$139,010	
Region 3 RTA	$9,143		$891,138	$197,757	$282,580
Region 4 SRTS	$6,330		$561,539	$158,592	$216,936
TOTAL	**$128,702**	**$1,088,915**	**$10,132,121**	**$2,261,456**	**$1,582,119**
Average per Agency	**$5,850**	**$136,114**	**$596,007**	**$161,605**	**$263,686**

In the final step in the utility-cost analysis, the total utility for each technology is divided by the total cost of that technology (and then multiplied by 10,000 for sake of viewing the results). The resulting utility-cost ratios for the recommended technologies are shown in Table 5.7.

Table 5.7
Utility-Cost Ratios

	Vehicle maintenance software	Computer-assisted scheduling software	Data communication & MDTs	Fully automated scheduling software	AVL
Utility-Cost Ratio – Total Cost	5.13	1.17	0.21	0.87	1.21
Utility-Cost Ratio – Average Cost	11.28	0.93	0.36	1.22	0.73

These results suggest that the recommended technologies be deployed throughout the state with the following priority:

- Vehicle maintenance software (highest priority)
- AVL
- Computer-assisted scheduling software
- Fully automated scheduling software
- Data communication and MDTs (lowest priority)

The utility-cost ratio that utilized the average cost of each technology per agency yielded only slightly different technology priorities, as follows:

- Vehicle maintenance software (highest priority)
- Fully automated scheduling software
- Computer-assisted scheduling software
- AVL
- Data communication and MDTs (lowest priority)

5.3. Conclusions and Recommendations

The utility-cost analysis clearly shows that the top (and least-cost) priority should be for Iowa DOT to invest in vehicle maintenance software for all 22 agencies included in the analysis. It is a low-cost technology that can facilitate the collection, processing, filing, and analysis of maintenance information in a paperless environment.

The utility-cost analysis also shows that data communication and MDTs should be considered as a low priority item. While this differs from the TranSystems' Team's initial recommendation on this technology's relative priority, the analysis makes it clear that the other technologies should be considered as higher priorities, since they have the potential to better meet the goals identified for deploying technology throughout the state.

Computer-assisted scheduling is recommended to be deployed as a second priority throughout the state. The reason for this recommendation is that most of the agencies that were identified as having a need for some automation (but not full automation) have little right now in the way of scheduling tools. Much of their scheduling is accomplished using paper and pencil. Thus, they would benefit more than those agencies that already have some type of scheduling tool.

Our recommendation for the next priority is to deploy fully automated scheduling. The reason for this is that (1) it is should be in-place before AVL is considered for deployment; and (2) it will improve the scheduling and dispatching process, and operations for those agencies that already have some computer-assisted tools. AVL can be added at any point after fully automated scheduling is in-place for the two agencies identified.

6.0 IMPLEMENTATION STRATEGIES FOR ITS

Iowa Department of Transportation

TRANSIT ITS

6.1. Procurement Strategy

The purpose of Task 8 (in Phase IB) was to examine the opportunities for economies of intelligent transportation systems (ITS) software and hardware through standardization and interoperability, and to consider various procurement strategies. One of the most critical questions related to funding and procurement is whether economies of scale can be achieved if multiple transit agencies purchase the same ITS software and hardware. For example, there is a significant difference in the cost of purchasing 250 mobile data terminals (MDTs) vs. purchasing 20 MDTs. The underlying issue is whether or not the same ITS hardware and software is appropriate for multiple agencies.

Based on the work that was accomplished in Phase IA, and Tasks 5, 6, and 7 of Phase IB of this project, and experience from elsewhere, there is strong evidence that economies of scale can be gained by procuring transit ITS components for multiple Iowa transit agencies at the same time, or using a statewide contract/purchase order for these components.

There are several ITS procurement strategies available to Iowa DOT. Before a discussion of each method, it is important to briefly explore issues that should be considered before the procurement process. First, ITS procurements need to be flexible and adaptable. Purchasing ITS systems is not like purchasing a bus or tires for a bus. Procurement processes need to be flexible and adaptable to the facts and circumstances surrounding each procurement. It is important to provide an environment that offers the maximum range of procurement options and strategies.

Second, being prepared to overcome contracting barriers at various institutional levels and during project phases is important. The following tools can overcome typical contracting barriers:

- Partnering with other public and private sector entities;
- Enacting new or revised legislation;
- Selecting funding sources that allow flexibility;
- Leveraging intellectual property rights;
- Utilizing private sector cost sharing with reasonable compliance requirements;
- Carefully segregating, bundling and drafting contract scopes of work;
- Promoting competition among pre-qualified offerors;
- Utilizing evaluation and award criteria which are fair and flexible; and
- Incorporating expedited dispute resolution procedures.

Third, involving procurement personnel early in the planning process enhances the project’s chance of success. Since it has been difficult for transit agencies or State DOT transit personnel to develop procurement expertise when dealing with ITS, they may want to consider outside help from a consultant with innovative procurement expertise.

At this point, two major questions need to be answered: (1) is the legal/procurement department/person or procurement ready and willing to handle a non-traditional procurement? and (2) can the agency be flexible in the type of procurement used?

Often, legal and procurement personnel are less likely to explore alternatives that they have not directly experienced than the primary stakeholders that are directly involved in the technology. This lack of flexibility can result in a less than ideal procurement. Also, is the agency able to choose the appropriate procurement method, or are they bound to use only a specific method due to agency or local rules? For example, Westchester County Department of Transportation (in Westchester County, NY), which operates fixed route and paratransit service, is not an authority and is thereby bound by County procurement rules. These rules dictate that all equipment procurements must use a bid process, rather than a request for proposal (RFP) process.

Basic Procurement Methods

There are four basic methods of procuring transit ITS systems and services, as follows:

- Invitation for Bid (IFB) (a.k.a. formally-advertised competitive bid);
- Two-step competitive bid (a variation on an IFB);
- Request for Proposal (RFP) (a.k.a. competitive negotiated procurement); and
- Sole source.

One additional method that is not typically used for transit ITS procurements is an unsolicited proposal. The last item, sole source, is usually not appropriate for procurements of this type because of their size and complexity. However, if the agency is exploring public/private partnerships, this may be possible.

An IFB is used when the specifications represent a final design, and when price is the only deciding factor. If the agency knows exactly what it wants to procure, the IFB is an appropriate method. The system or services being procured must be defined in detail by specifications; the selection of a vendor/contractor must be based on low price alone, once the bid is deemed responsive and responsible; and the specifications must reflect a final design and bidders cannot take any exceptions to the specifications. If a bidder is more qualified than other bidders and comes in at a higher price, they cannot be selected. Also, no negotiations can be held with bidders regarding technical or cost issues.

Most transit agencies do not have exact specifications because they are not quite sure of what they need. Also, agencies are typically procuring more than just hardware/equipment. A technology purchase involves hardware, software, installation, and other services. This type of purchase does not lend itself easily to an IFB process.

The two-step competitive IFB process is more flexible than the basic IFB since there is an opportunity to modify the specifications before completing the process. In this type of procurement, the agency “pre-qualifies” bidders. During the first step, potential bidders can take exception to the specifications and contract terms, and make suggestions about modifications while responding to the IFB. This is not allowed in the one-step IFB process. Once the agency reviews the responses, they can modify the specifications if they desire. Then, an addendum to the specifications would be issued to those who responded in the first step. Those bidders can then submit an amendment to their bid that responds to the addendum.

So, a two-step IFB is the same as an IFB except that prospective bidders are “tested” before being invited to submit a bid. They can take exception to contract terms and specifications in the initial “test” step. Then, an addendum is issued to the initial specifications that reflects exceptions and modifications. Bidders can then submit an amendment that responds to the modifications.

The RFP process works well for projects of the complexity and scope of advanced technology for transit. It allows much more flexibility than an IFB process, particularly since the specifications do not have to reflect a final design. Functional or performance specifications, or requirements checklists are often used in an RFP. The basis of an RFP is a Statement of Work (SOW). Proposals contain technical and cost sections that are reviewed separately. Proposal evaluation criteria extend beyond just cost - they may include cost, but cost is usually a minor criteria. Technical, management and cost criteria are often used. In addition, the proposers may be asked to conduct demonstrations of their systems, and the agency personnel may conduct on-site visits at agencies that have successfully deployed the proposers’ systems. The scope of services and the price can be negotiated when using an RFP process. Thus, an RFP process allows the greatest amount of flexibility.

All processes should incorporate a pre-bid/proposal meeting during which potential vendors/contractors can ask questions and get a better sense of the environment.

The selection of the most appropriate method is based on several factors. One factor is the agency’s procurement requirements. Another is the soundness of the specifications that describe the transit ITS systems and/or services. Most often, IFBs contain technical rather than functional specifications. Responses to IFBs are considered equal except for price - this process can only be done with technical specifications.

Selection of the Right Procurement Method

There are three bases for making procurement decisions: qualifications, cost and qualifications combined, and cost alone.

If an agency is seeking alternative approaches to a transit ITS system, the RFP approach is the appropriate procurement method.

Qualifications based procurements uses the RFP method (it does not have cost as a proposal evaluation criteria) or the sole source method, as well as the two-step qualifications, Letter of Interest (LOI) or Request for Qualifications (RFQ), then RFP and/or interview process. Two-step qualifications is just an extension of an RFP process – it includes more steps before the RFP is released.

Cost and qualifications combined use the two-step IFB described earlier, sole source, or an RFP process that includes cost as an evaluation criteria. Here, best and final offers (BAFOs) are often solicited from the top-ranked vendor(s)/contractor(s). This is also known as competitive negotiations.

Competitive negotiations involve the following process. Selection of a vendor is made of two or more offerors deemed to be fully qualified and best suited among those submitting proposals, on the basis of the factors stated in the RFP, including price. Negotiations are then conducted with each of the offerors selected. Price is considered, but need not be the sole determining factor. After negotiations have been conducted with each offeror, the agency makes a contract award to the offeror who, in the agency's opinion, has made the best proposal. The idea behind a cost and qualifications combined approach is to ensure that the agency is receiving the best value.

Cost alone, or low-bid, should be used only for fixed outcome projects. Fixed cost works best for fixed outcome projects. Cost alone is often inappropriate for ITS.

The factors that should be used to determine when to use qualifications alone or a qualifications and cost combined approach are as follows:

- Consider what you are buying. Is it intellectual property or real property or both?
- How difficult will it be to achieve the desired outcome? Will it be technically more difficult, or institutionally more difficult?

Once you have considered these factors, you can match the selection method to the outcome, as follows:

- Qualifications and cost combined works well if the product is a combination of services and products; and
- Qualifications alone work well for software alone, or services.

One cautionary note about a low-bid for software - this should be used only when bidding for items with very little or no software development/integration.

Procurement Recommendations

This section is divided into two subsections. The first describes recommendations regarding purchasing the same hardware/software for multiple agencies, and the second discusses the recommended procurement strategies that should be used by either each transit agency or the state to procure transit ITS hardware, software and services.

Multiple Agency Procurement Recommendations

Given the information presented earlier in this report about integration and interoperability, and the information about the technology profile associated with each regional and small urban/rural transit system in Iowa, we recommend that multiple agencies purchase the same hardware and software where possible.

There is an opportunity for economies of scale when scheduling software and MDTs are being considered for deployment. A total of 560 vehicles are covered in Technology Levels 3 and 4. Given that the majority of MDT procurement involves in-vehicle hardware and software, procurement of 560 units versus as many as 73 at a time will potentially yield lower cost units.

Further, we recommend that all agencies, with the exception of Technology Level 1 and Level 2 agencies, deploy a data communication system. The alternatives regarding data communications were described in Working Paper 5 – Inventory of Statewide Communications Resources.

Because vehicle maintenance software is being recommended for every agency included in this study, Iowa DOT should purchase this software on a statewide basis for all of these agencies. South Carolina DOT (SCDOT) made OmniFleet® Equipment Maintenance Management Software from Resolute Solutions Corporation available to all transit agencies throughout the state, rather than having each agency develop specifications and go through a whole procurement process.

Recommended Procurement Strategies

Given the information presented earlier in this report about various procurement and selection methods, we strongly recommend that an RFP process be used for the majority of procurements of transit ITS for Iowa. The only time that an IFB should be used is when only equipment is being purchased, and that type of equipment is well defined. IFBs can probably be used for some data communications equipment, as well as MDTs. However, if MDTs are being purchased and must interface with scheduling and dispatching software, they should be part of procurement for the software. This is due to the fact that interfaces between the scheduling software and the MDT will be required to be developed (if they do not already exist).

Use of an RFP process for procuring the majority of the transit ITS hardware, software, and services requires the following decisions:

- Iowa DOT must decide if it becomes the "procuring agency" for the transit ITS;
- Whether or not Iowa DOT becomes the procuring agency, a decision must be made about whether to develop specifications internally or externally (using a consultant); and
- Iowa DOT must determine if it is possible to set-up a contractual vehicle that agencies can use to purchase their transit ITS systems.

There are several pros and cons to having Iowa DOT be the focal point for all transit ITS procurement for the rural, small urban and regional transit agencies in Iowa. On the positive side, each transit agency would not have to conduct the whole procurement process themselves. This not only eliminates duplication of effort, but also allows each agency to focus their efforts on the deployment, rather than the procurement activities. Further, once Iowa DOT sets up a procurement process for transit ITS and becomes familiar with the process, no additional effort will be required to assist agencies that wish to procure transit ITS.

On the negative side, having Iowa DOT as the focal point may require that additional external help be retained to develop the procurement process and to provide the necessary technical assistance to each agency as transit ITS is being procured. Further, having Iowa DOT as the Procuring agency may be perceived as taking some control away from each agency.

The issue regarding specifications development is important since most of the agencies included in this study do not have the internal personnel with the appropriate expertise to develop the necessary specifications for transit ITS systems. Further, Iowa DOT may not have the in-house personnel to develop these specifications.

The final issue – setting up a statewide contractual vehicle to facilitate the procurement of transit ITS by agencies – will require that either Iowa DOT or an external party develop this vehicle and make it available to the agencies that are interested in procuring transit ITS using this vehicle.

For example, in Massachusetts, there is a State Purchase Program[7] that allows certain agencies to utilize Statewide Contracts for selected commodities and services. There are two primary benefits to this approach: (1) goods and services can be purchased directly by agencies from Statewide contractors at a low price negotiated by the Commonwealth of Massachusetts; and (2) agencies do not have to conduct a competitive procurement on their own.

This type of vehicle has been used for procuring transit ITS in the past. However, there is not a vast amount of experience with this type of procurement vehicle.

Thus, our recommendations regarding the three decisions are as follows:

- Iowa DOT should become the procuring agency;
- Specifications should be developed by an external party; and
- A statewide procurement vehicle should be developed for agencies to procure transit ITS.

Illustration of Iowa Dot's Potential Procurement Role

This section attempts to clarify the role Iowa DOT could play in the procurement of technology for the state's transit systems.

For example, if Iowa DOT were going to support the statewide deployment of transit maintenance management software (MMS), they would take one of two approaches. In both approaches, Iowa DOT would have specifications for this software developed by an outside contractor. These specifications would be functional in nature, and would take into account the needs of the rural and small urban transit providers throughout the state, as described in the ***Iowa DOT Statewide Rural Transit ITS Deployment Plan***. The contractor developing the specifications would update the needs for MMS identified in the ***Deployment Plan*** by contacting several of the agencies that have more significant needs for MMS. Once the specifications are developed and approved by Iowa DOT, they would be included in an RFP document issued by Iowa DOT. This RFP would include information about the transit agencies/providers that may purchase or be given MMS.

At this point, Iowa DOT would need to select one approach - either purchasing the MMS for all participating providers or having interested providers purchase the MMS from a state-approved list of vendors at a cost less than they would receive if they procured the MMS themselves.

In any case, the RFP would include Iowa DOT's standard procurement "boiler plate" language describing Iowa DOT's contractual requirements in addition to the specifications. While responses to the RFP are being prepared, Iowa DOT should develop (or have the specifications contractor develop) a Proposal Evaluation Plan, so that each person who will be evaluating the proposals will evaluate the proposals in a consistent manner.

Once responses to the RFP are received, the Iowa DOT evaluation team, which should include representatives from several participating transit providers in addition to Iowa DOT representatives, will evaluate the proposals to determine which vendor's MMS meets the requirements set forth in the specifications. After a selection is made, either the winning vendor's MMS is placed on a list of approved transit MMS products that can be purchased by

[7] "OSD [Massachusetts Operational Services Division] POS [Purchase of Service] State Purchase Program," http://www.state.ma.us/osd/pos/info/psppdesc.pdf and http://www.state.ma.us/osd/pos/dps.htm

transit providers via a statewide contract, or a specific number of MMS licenses are purchased by Iowa DOT and distributed appropriately to the participating transit providers.

In either approach, Iowa DOT should ensure that an adequate amount of training is provided to the providers that will be receiving the MMS. This requirement should be clearly stated in the RFP in addition to other requirements such as installation, testing and documentation.

Either of these procurement approaches will:

- Reduce the effort required by individual agencies to procure transit ITS systems;
- Reduce the capital cost of all systems procured using this approach because of the multiple agency nature of the procurement;
- Centralize the procurement process within Iowa DOT; and
- Facilitate Iowa DOT's monitoring of transit ITS deployment in rural and small urban transit systems.

6.2. Standardization and Interoperability

Early on in this project, the need for standardization and interoperability among the rural and small urban transit systems in Iowa was identified. This need requires that the appropriate transit ITS standards be identified and the issues associated with interoperability among systems be described. The following subsections present information about existing standards and their use and about interoperability among transit systems in Iowa.

Standardization

There are a limited number of standards for transit ITS software and hardware. However, these should be strongly considered for use to ensure that ITS products purchased in the future for various agencies all adhere to existing and proven standards.

Appropriate ITS standards must be identified for each information flow in an ITS architecture (see Task 6 report). Establishing regional and/or statewide standards for exchanging information among ITS systems is important not only from an interoperability point of view; it also reduces risk and cost since a region and/or state can select among multiple vendors for deployment products[8].

ITS standards address interfaces between ITS systems, so typically, the ITS stakeholders in a region and/or state should have reached consensus on the information flowing between each pair of ITS systems in a region and/or state prior to identifying applicable standards. If interfaces defined in the Regional and/or Statewide ITS Architecture are not mature, stakeholders should agree on an interim standards approach.

In general, each information flow has up to three types of standards that are relevant: a message set standard, a data element standard, and one or more communications protocol standards. Especially in the area of communications protocols, there are various technology

[8] A report identifying ITS standards supporting regional and national interoperability is a required component of a Regional ITS Architecture according to the FTA Policy on ITS Architecture Consistency.

choices that a region and/or state can make. For this project, we will recommend specific standards that the state of Iowa should consider to ensure standardization of transit ITS hardware and software purchased by the rural and small urban transit systems, and to ensure interoperability among systems.

Before describing the applicable standards for transit ITS in Iowa, it is important to discuss the consideration of standards, particularly standards maturity. The maturity of ITS standards was reviewed prior to selection in terms of the following:

- Has the standard been approved or published one or more of the standards development organizations (SDOs)?
- Has the standard been adopted by multiple vendors?
- Has the standard been tested?
- Is there an amendment to the standard in process, and how much will it change as a result?

In addition to the interface standards that are being defined for ITS, a range of other regional and/or statewide standards may be considered that would facilitate interoperability and implementation of a Regional and/or Statewide ITS Architecture. For example, standard base maps, naming conventions, measurement and location standards, and organizational structure identifiers can all facilitate the meaningful exchange of information between systems in a region/state. These types of regional/statewide standards should also be considered and can be included in the standards documentation at the discretion of the region/state.

The leading applicable transit ITS standards include the Society of Automotive Engineers (SAE) J-1708 vehicle area network (VAN) standard and the Transit Communications Interface Profiles (TCIP) standards. The VAN standard provides a common backbone by which ITS systems and data can be linked on a vehicle. SAE J-1708 is a slow, low bandwidth multiplex bus standard. Currently, there is an effort to migrate to SAE J-1939, which has higher speed and greater bandwidth than J-1708. SAE J-1939 is not supported currently by all transit ITS vendors.

TCIP is a suite of data definition/interface standards for the transit industry. The TCIP standards define all the information used by transit agency systems in a standard way, with standard names and formats. They are like many other standards that have been used for commerce for decades, such as standards for electronic purchase orders and invoices. For new systems, they may be used directly for structuring databases and programs. But even if they are not, program interfaces can be built around the standards. In the future, when standards use reaches a critical mass, these standards should make it easier to interface between agency systems and vendor software, or between two vendors' software products.

There are three levels of conformance with TCIP, as follows:

Level 1	Data (data elements). Level 1 requires that legacy systems/applications be able to translate between proprietary system and TCIP data elements;
Level 2	Message (Level 1 and Message Sets). Level 2 requires support of Level 1 **AND** the ability to map proprietary objects/entities (message structures) to TCIP data elements and messages; and
Level 3	Dialog (Level 2, dialog patterns and implementation specification). Level 3 requires Level 2 **AND** support of the library of TCIP Application Programming Interfaces (APIs).

Interoperability

Interoperability is defined as the ability of ITS systems:

- To provide information and services to other systems;
- To accept information and services from other systems; and
- To use the information and services that are exchanged to operate together effectively.

There are three types of interoperability. Systems must be able to communicate and operate effectively together at the following levels:

Technical	Ability of equipment (hardware and software) to communicate (i.e., send and receive information);
Procedural	Common procedures to exchange meaningful information (i.e., interpret and understand the information); and
Institutional	Administrative and/or contractual agreements between operators and users of the information (e.g., financial transactions among accounts).

As initially presented in Task 3, the difference between ITS integration and interoperability is as follows:

Integration is sharing infrastructure, exchanging information, and using data for control; and **Interoperability** is using standardized protocols to accomplish the same goals.

In Working Paper 7, there was a discussion of the considerations and challenges associated with integration and interoperability of transit ITS in Iowa. It is recommended that Iowa DOT consider the integration of transit ITS among those operators whose service is coordinated, as well as interoperability of transit ITS systems throughout Iowa. The reason for this recommendation for interoperability can be summarized in the following bullets. Implementing and deploying the same transit ITS systems in rural and small urban agencies across the state will:

- Lower the risk associated with each deployment;
- Lower the costs associated with each deployment[9] from;
  - Elimination of duplicate testing environments (labs, platforms, testing personnel);
  - Standardization of information technology (IT) specifications;
  - Leveraging of software license purchasing power;
  - Standardization of system configuration and user guides; and
  - Common system support;
- Increase the body of knowledge about specific systems throughout the state;
- Provide a supportive environment among agencies that have the same systems;
- Encourage more vendors to compete in order to have a statewide market for their products; and
- Increase the efficiency and effectiveness of the services provided by the agencies that deploy these systems.

[9] Adapted from "Benefits of a "Virtual Enterprise," http://www.isg-scra.org/transit/srts/srts-VTEProject.html

6.3. Strategies for Technology Support

ITS applications require a level and type of ongoing support that Iowa's transit agencies do not have access to. This support is a fundamental requirement for successful Transit ITS deployment. There are several ways to secure this support, each with advantages and disadvantages.

1. The agency can contract with the vendor to provide support for a period of time through warranties and maintenance/service agreements. The advantage is that the costs can be included as part of the initial procurement, and the vendor has familiarity with the products. Disadvantages are that access and response time can be limited, and the service agreements usually have a term that makes the agreements "temporary."

2. The agency can hire a staff person to provide the needed support. This will provide the highest level of support in terms of response time. The disadvantages involve cost. It is unlikely that any of the applications contemplated in the five-year time frame will require the services of a full time system administrator. Furthermore, the cost of the additional staff person is not a reasonable expense for the transit agencies to cover. However, it is important for agency staff to be trained in the basics of system support (e.g., simple diagnostics) to provide a level of in-house support. If possible, a staff person with an interest or aptitude for technology can be provided additional training to offer a higher level of in house support.

3. The agency can "borrow" support from another organization, such as a city or county, that may have the resources (and the need) for IT support. The advantages include lower cost and accessibility. The disadvantages may be that the transit system is a lower priority, and the individual may not be familiar with the intricacies of the transit applications. This type of borrowed support may be best suited for standard office hardware and software systems, but may need to be augmented for the transit specialty systems.

4. Transit agencies can pool resources to secure technical support. This can be through a contract provider, or hired staff. Another possibility is to secure these services collectively through an arrangement with one of the state's universities. Iowa DOT may be able to assist with such an arrangement.

Information Technology Support Recommendation

The recommended approach to the important task of ongoing support for ITS systems is actually a combination of the approaches summarized previously.

- The agency should procure at least two years of IT support from the vendor that provides system integration services. This will allow the agency to "capitalize" much of the IT support, and will carry the project through the initial period when problems and issues are more likely to surface. In addition, the vendor's service personnel can help familiarize and train agency staff on the system.

- The agency should identify and train an individual to have lead agency responsibility for the system. This individual need not be an ITS "expert", but should be familiar with the system and the diagnostics that can be used to troubleshoot problems that occur. In addition, this individual should be familiar with services that can be provided by others, including the vendor and contract service providers. In this case, the agency's system administration can direct the activities of external service personnel.

- The agency should also be prepared to secure the services of contract service personnel at a minimum after the term of the vendor provided support. This support can be most efficiently secured through a contract with a firm experienced in general IT systems and transportation related ITS applications. These services should be secured through a pooled arrangement with other agencies, possibly using the state as a means to secure the services. Work can be assigned on a task order basis on an as-needed basis.

The provision of ongoing support is so important to the success of ITS deployment that this should be a required component of projects for state financial assistance.

6.4. Funding Strategy

Transit ITS applications are not inexpensive. Most transit ITS projects in the U.S. have been funded through a combination of federal, state, and local funding. Funding from the state and local levels allows local transit agencies to offset the initial capital cost of ITS projects. This is especially important for small urban and rural agencies that do not typically have large capital budgets.

Federal funding for transit ITS projects can come from the Federal Transit Administration's (FTA) grant programs such as 5307 formula funding, 5309 discretionary capital funding and 5310 and 5311 programs for rural areas. However, funding from these programs is usually used for other purposes, such as bus replacement, making it difficult to use FTA funding for "special" projects. 5309 capital funding can be secured specifically for ITS projects therefore representing "net new funding" for the state's transit agencies.

Overall, ITS funding at the Federal level is provided through a few vehicles. Deployment funding is given through the ITS Integration component of the ITS Deployment Program. Funds are capped at not more than $35 million for projects in any one State. Projects are selected through competitive solicitation and must meet certain detailed criteria.

The Federal Highway Administration (FHWA) also makes funding available for transit ITS projects. Thus far, Iowa DOT has received two FHWA grants for transit ITS, the initial for $1.9 million and the second for about $400,000 for a total of approximately $2.3 million. These funds can be used for 50% of the total project costs, although other federal funds can be used for funding as well up to a total of 30%. Thus, the total federal portion of the project cost cannot exceed 80%. State or local funding must provide the remaining 20%.

The US Department of Transportation is committed to the deployment of technology to make existing transportation systems more efficient, thus funding from federal sources is likely to be available in the future. Funding for ITS projects is expected to transition from being considered a special application to being included a part of any transportation improvement. This concept, referred to as "mainstreaming," will result in funds for ITS projects being allocated from traditional grant programs and projects.

Iowa DOT has addressed the issue of funding for ITS projects for transit and other transportation applications. The Iowa DOT Transportation Commission has dedicated federal funding through the Congestion Mitigation and Air quality (CMAQ) program for ITS projects. In the past, funding for ITS projects was derived from the difference between what the state received from funding from the federal government from the period 1998 to 2003 versus the CMAQ funding received during1991 to 1997.

A portion of the state's CMAQ funding may be available for Transit ITS projects in the future.

Currently, Iowa DOT has approximately $2 million available to fund transit ITS projects statewide from the FHWA grants. This funding is restricted to projects in non-urban areas, or those involving coordination between rural and urban areas.

Other federal funds, including CMAQ funding, can be used to match a portion of the FHWA grant.

Finally, local or non-federal state funds need to make up at least 20% of the total project cost. It is likely that transit agencies will be required to provide this funding.

Figure 6.1 is a summary of current fund availability for transit ITS projects in the state of Iowa.

Figure 6.1
Iowa Transit ITS Funding Summary

Funding Source	Maximum Percentage of Total Cost	Total Funding
FHWA Grant	50%	$2.0 million *
Other Federal Programs	0% - 30%	0 to $1.2 million
Local	20% - 50%	$0.8 to $2.0 million
Total	100%	$4.0 million

*$2.3 million total, less $300,000 for Statewide Transit ITS Deployment Plan.

Figure 6.1 shows that the total funding could reach $4.0 million if sufficient state and local funding was available to take full advantage of the 50% FHWA grant.

Information on the cost of deployment of ITS at Iowa transit agencies is presented in Section 7 of this report, and the individual Preliminary Agency Technology Deployment Plans in the Appendix. The $4 million would be adequate to fund deployment of a significant portion of the deployment plan, and possibly one or two "demonstration" projects of advanced communications and AVL at the larger regional systems. Thus, the level of funding potentially available is sufficient to fund significant short-term transit ITS projects statewide in Iowa.

Recommendations

Iowa DOT should adopt a funding strategy or policy to guide how state and federal funds will be used to deploy technology for transit agencies throughout the state. At a minimum, projects should be consistent with the Transit ITS Deployment Plan and the statewide architecture formulated in the Statewide ITS Deployment Plan in July 2001.

Transit agencies should be required to provide a minimum of 20% local funding. Local funding in excess of 20% may be required if funding from other sources is unavailable. Local funding in excess of 20% (i.e., overmatch) could be viewed as a positive in the evaluation of project applications.

It was noted that CMAQ funding Iowa DOT is “reserving” for ITS deployment might not be available for transit projects. Competition for CMAQ funds is great, and use of CMAQ funds for transit projects is not guaranteed, and will be contingent upon a careful review of the project’s costs and benefits. Transit interests should establish their position with respect to state ITS funding and petition Iowa DOT management for a share of state funding consistent with the Iowa Statewide ITS Deployment Plan.

Larger more costly deployments will quickly exhaust available funding. For example, implementation of data communications and MDTs can be expected to cost $200,000 to over $1 million at a regional transit system, depending upon the system’s size. Other funding should be pursued for these projects, such as a FTA 5309 earmark. This will reduce the impact of these large projects on the statewide program, and will place more responsibility for project funding on the local agency.

As federal funding programs change (for example with the next federal transportation bill), Iowa DOT should become familiar with potential funding sources. The Iowa Public Transit Association, and the Associations lobbyist, can assist with this.

6.5. Staging and Timing

The implementation of the types of ITS applications being considered for Iowa transit systems requires a period of two to three years at the very minimum. It is suggested that the deployment plan adopt an implementation schedule of five years. A five-year implementation schedule allows for the necessary systems planning, specification development, procurement and implementation steps. Although different applications vary in the amount of time required, the project’s schedule and staging plan should reflect this time frame.

Figures 6.2 through 6.6 show general schedules for ITS applications implementation. In each case, approximate elapsed time is shown for phases or primary task categories:

Agency plan development will require one or two months, even after completion of the statewide plan. This phase could take longer if local decision making dictates.

Specification development will require one or two months. Joint or centralized procurement could reduce this phase because the same specification (with minor modifications) can be used by other agencies.

Procurement will require at least three to four months from the time the specifications are completed to the time a notice to proceed is issued to a vendor.

Installation of ITS applications varies with the complexity of the project, with large projects requiring six months or more.

Testing is critical to the success of the application and should not be compromised. After installation is complete, a period of at least a month even for straightforward projects is needed, with complex projects requiring more time.

Figure 6.2
Vehicle Maintenance Software
Timing and Staging Plan (7 months)

Month →

Phase	Description	1	2	3	4	5	6	7	8	9	10	11	12
1	Agency Plans	1 mo.											
2	Specifications		1 mo.										
3	Procurement			3 mos.									
4	Installation						1 mo.						
5	Testing							1 mo.					
6	Acceptance												

Figure 6.3
Computer-Assisted Scheduling Software
Timing and Staging Plan (9 months)

Month →

Phase	Description	1	2	3	4	5	6	7	8	9	10	11	12
1	Agency Plans	2 mos.											
2	Specifications			1 mo.									
3	Procurement				3 mos.								
4	Installation							2 mos.					
5	Testing									1 mo.			
6	Acceptance												

Figure 6.4
Fully-Automatic Scheduling Software
Timing and Staging Plan (12 months)

Month →

Phase	Description	1	2	3	4	5	6	7	8	9	10	11	12
1	Agency Plans	2 mos.											
2	Specifications			2 mos.									
3	Procurement					4 mos.							
4	Installation									3 mos.			
5	Testing												1 mo.
6	Acceptance												

Figure 6.5
Data Communications & MDTs
Timing and Staging Plan (16 months)

Month ⇨

Phase	Description	2	4	6	8	10	12	14	16
1	Agency Plans	2 mos.							
2	Specifications		2 mos.						
3	Procurement			4 mos.					
4	Installation					6 mos.			
5	Testing								2 mos.
6	Acceptance								

Figure 6.6
Automatic Vehicle Location (AVL)
Timing and Staging Plan (13 months) [1]

Month ⇨

Phase	Description	2	4	6	8	10	12	14	16
1	Agency Plans	2 mos.							
2	Specifications		2 mos.						
3	Procurement			4 mos.					
4	Installation					3 mos.			
5	Testing						2 mos.		
6	Acceptance								

1 - Assumes Data Communications have already been installed

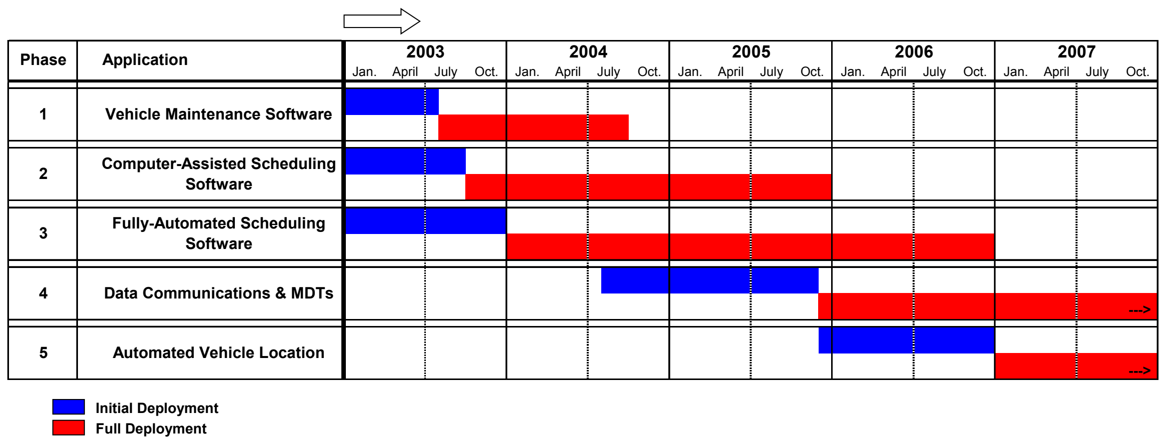
Experience has shown that a staged implementation of technology applications on a statewide basis is prudent. That is, instead of attempting to implement technology in all or most transit agencies at once, a smaller number of "demonstration" agencies should be selected for the initial stage. After successful implementation at the demonstration agencies, implementation can be completed at other agencies. In this manner, agencies can learn from the experience of their peers, and statewide resources can be better focused.

This staged implementation can be used even with joint or statewide procurement. The procurement documentation (e.g. RFP) should specify a staged development plan and should identify the agencies and time intervals required for deployment.

The staged implementation concept also applies within an agency. For example, agencies should not attempt to implement several different technologies at one time. Rather, the successful implementation of one technology should be followed by the next project. This staging approach can even be applied to components in an integrated system. For example, AVL can be added after a computerized scheduling system is in place, and after data communications are established. Again, this need not require separate procurements, rather a timing and staging plan within a single procurement.

Figure 6.7 depicts a staging plan that incorporates the concept of using an initial deployment for a smaller number of agencies, then full deployment over a longer period of time. The schedule also stages the implementation of separate technologies.

Figure 6.7
5-Year Transit ITS Staging Plan



Thus, the Statewide Transit ITS Deployment Plan should be regarded as a five-year plan, with an implementation horizon from 2003 to 2007. This staging plan not only makes implementation more manageable, but also makes better use of available funding.

7.0 THE IOWA STATEWIDE TRANSIT ITS DEPLOYMENT PLAN

7.1. Plan Element 1 - Statewide Plan Framework

This section summarizes the recommended Statewide Transit ITS Plan in terms of key findings and recommendations.

Institutional

*Definition of State Role***.** Iowa DOT has already taken a leadership role in ITS planning among the state's transit systems by securing funding and coordinating the deployment study project. This involvement is positive and Iowa DOT can provide important resources, expertise, and direction for ITS deployment.

Recommendation:
Iowa DOT, through the Office of Public Transit, should provide technical assistance to the state's transit agencies through Iowa DOT staff and consultants contracted to perform specific tasks.

Recommendation:
It is further recommended that Iowa DOT take the lead in developing a statewide program to provide ongoing technical support to the state's transit agencies. This program should consist of DOT staff and contracted services.

Recommendation:
Iowa DOT should require that transit agency coordination and service coordination be considered part of any transit ITS project submitted for state financial assistance. Projects should also consider opportunities for integration with other (non-transit) ITS applications. This way, the state can help assure that resources directed toward ITS deployment are expended in the most effective manner. Projects do not necessarily need to include these coordination elements, but should at least consider them during the systems planning process.

Recommendation:
A standing working group comprised of transit agency representatives should be created. This working group can be an extension of the Steering Committee, and could have a role in recommending projects for funding to Iowa DOT. The working group could also serve as a resource as technology is deployed throughout the state.

ITS Applications

Recommendations:

Vehicle Maintenance Software should be used for all of the state's transit systems. The state's investment in vehicle fleets justifies this requirement. Iowa DOT should arrange to procure the same software for all agencies as a means of reducing initial and ongoing costs. Transit agencies that already use some form of automated vehicle maintenance need not use the standard application.

Reservations and Scheduling Software should be used for all of the state's transit systems. This application can lead to operational and administrative efficiencies, and provide flexibility to allow transit agencies to serve more customers. The features included in the software depend upon the size and scope of the individual transit agency. Some agencies warrant "high-end" fully automated systems, while other smaller systems require only computer-assisted software. A preliminary determination in this regard was made by the Deployment study and should be revisited during the Agency Plan development process.

The state should also investigate the practicability of developing a spreadsheet/database-based program for use by the state's smallest agencies (TTP level 1 agencies). This approach may provide many of the benefits of commercial software at significantly lower cost.

Data Communications and Mobile Data Terminals (MDTs) are recommended for the state's larger regional systems to improve communications between dispatch and vehicles in service. In a paratransit operation, text messaging can help improve efficiency by transmitting the trip manifest for the run directly to the vehicle, as well as any real-time manifest changes during daily operations. The driver can use the MDT to indicate the completion of each pick-up and drop-off, and this information can be transmitted back to dispatch in real-time. This information can be used for trip verification and billing purposes. MDTs can enable further enhancements to daily operations through computer-aided dispatch (CAD) and automatic vehicle location (AVL) software.

The state should also investigate the possibility of data communications using phone lines or the Internet to provide some of the benefits, without real-time communications. Some transit agencies may find this an acceptable lower-cost alternative to real-time communication. It is likely that agencies in TTP level 3 that do not have plans to migrate to AVL technology will find the delayed-data communication systems adequate.

Automatic Vehicle Location (AVL) is a possible application for several of the state's largest regional systems (TTP level 4). AVL software operating at a central dispatch location receives periodic location reports from each vehicle in the field and then updates the vehicle locations displayed on a GIS map. Time-stamped location data can also provide dispatchers with schedule adherence information by exception (this schedule adherence feedback is also often provided to the drivers on the MDT). The dispatcher can view detailed information about a particular vehicle, by clicking its map symbol or by checking a table that provides current information about the entire fleet.

Because data communications and AVL are high cost applications, the need for and benefits from AVL should be evaluated in greater detail in the Transit Agency plans prior to embarking on the project.

Transit User Information. A need for advanced systems to support the customer service function was not found during the deployment study. Generally, agencies reported that their clients do not use or have available Internet and email access, and that the operations do not lend themselves to information displays at locations in the service area (i.e., there are few primary boarding locations). Transit agencies should be encouraged to use available technology to provide better information to the public. All agencies should use voice mail systems (or at least recording devices) for their call centers to allow the public comprehensive access to reservations, etc. The use of cable TV, and static web-based displays along with email for reservations are other examples of inexpensive applications of current technology.

Fare Payment and Rider Identification. A need for Electronic Fare Payment systems used in conjunction with MDT's and Transit Management was not found in the time period of the Deployment Study (five years). However, electronic rider identification cards may be used effectively with data communications systems deployed by TTP level 3 and 4 transit agencies. Unlike electronic fare payment cards, rider ID cards do not carry value for fare payment, rather simply rider information. These ID cards are relatively inexpensive, and require less overhead compared with fare media cards, and could be implemented as part of the data communications system.

Communications Strategy

Recommendation:
The opportunity to use existing state-owned radio communications infrastructure does not appear viable in the three to five year time frame. The design of these systems does not lend itself to the needs of most transit agencies. This is especially true for the regional systems that have extensive service areas. However, the Office of Public Transit should be alert for opportunities to partner with DOT's communications unit where unexpected opportunities present themselves.

Recommendation:
The Office of Public Transit should make clear the communication needs of transit agencies and the expectation that transit will be included in any future state initiative to upgrade radio communications. This should be communicated in writing along with a functional requirement for communications in both urban and regional transit agencies.

Recommendation:
The Office of Public Transit should assume a lead role in pursuing and managing a cooperative relationship with private communications firms with statewide infrastructure where such a relationship is beneficial to transit agencies. The ability to transmit and receive data is a requirement for some transit operations applications. Generally, the need to provide for data communications to support ITS applications such as Mobile Data Terminals (MDT's) and AVL is expected to be the greatest challenge that may be met through a partnership with the private sector.

Funding

Recommendations:
Iowa DOT should adopt a funding strategy or policy to guide how state and federal funds will be used to deploy technology for transit agencies throughout the state. At a minimum, projects should be consistent with the Transit ITS Deployment Plan and the statewide architecture formulated in the Statewide ITS Deployment Plan dated July 2001.

Transit agencies should be required to provide a minimum of 20 percent local funding. Local funding in excess of 20 percent may be required if funding from other sources is unavailable. Local funding in excess of 20 percent (i.e., overmatch) will be viewed as a positive in the evaluation of project applications.

It was noted that the CMAQ funding that the Iowa DOT is "reserving" for ITS deployment might not be available for transit projects. Competition for CMAQ funds is great, and use of these funds for transit projects is not guaranteed, and will be contingent upon a careful review of the project's costs and benefits. Transit interests should establish their position with respect to state ITS funding and petition Iowa DOT management for a share of state funding consistent with the Iowa Statewide ITS Deployment Plan.

Larger more costly deployments will quickly exhaust available funding. For example, implementation of data communications and MDTs can be expected to cost $200,000 to over $1 million at a regional transit system, depending upon the system's size. Other funding should be pursued for these projects, such as a FTA 5309 earmark. This will reduce the impact of these large projects on the statewide program, and will place more responsibility for project funding on the local agency.

As federal funding programs change (for example with the next federal transportation bill), Iowa DOT should become familiar with potential funding sources. The Iowa Public Transit Association, and the Associations lobbyist, can assist with this.

Timing and Staging

Recommendation:

The Statewide Deployment Plan should be regarded as a five-year plan, with a horizon from 2003 to 2007.

Recommendation:

Instead of attempting to implement technology in all or most transit agencies, a smaller number of "demonstration" agencies should be selected for the initial stage. Experience has shown that a staged implementation of technology applications on a statewide basis is prudent. After successful implementation at the demonstration agencies, implementation can be completed at other agencies. In this manner, agencies can learn from the experience of their peers, and statewide resources can be better focused.

The staged implementation concept also applies within an agency. For example, agencies should not attempt to implement several different technologies at one time. Rather, the successful implementation of one technology should be followed by the next project. This staging can even be applied to components in an integrated system. For example, AVL can be added after a computerized scheduling system is in place, and after data communications are established.

Procurement Strategies

Recommendation:
An RFP process should be used for the majority of procurements of transit ITS for Iowa. The only time that an Invitation for Bid should be used is when only equipment is being purchased, and that type of equipment is well defined.

Recommendation:
Iowa DOT should become the procuring agency for transit ITS projects, in partnership with transit agencies. Each transit agency would not have to conduct the whole procurement process themselves. This not only eliminates duplication of effort, but also allows each agency to focus their efforts on the deployment, rather than the procurement activities. Further, once Iowa DOT sets up a procurement process for transit ITS and becomes familiar with the process, no additional effort will be required to assist other agencies that wish to procure transit ITS.

Recommendation:
An external party familiar with transit technologies should develop specifications. The issue regarding specifications development is important since most of the agencies do not have the internal personnel with the appropriate expertise to develop the necessary specifications for transit ITS systems. Further, Iowa DOT may not have the in-house personnel to develop these specifications.

Recommendation:
A statewide procurement vehicle should be developed for agencies to procure transit ITS. This would allow certain agencies to utilize Statewide Contracts for selected commodities and services. There are two primary benefits to this approach: (1) goods and services can be purchased directly by agencies from Statewide contractors at a low negotiated price, and (2) agencies do not have to conduct a competitive procurement on their own.

7.2. Plan Element 2 – Individual Agency Plans

The Statewide Transit ITS plan provides general plans for the deployment of ITS applications in the state's transit agencies. The Statewide plan provides a very good starting point for transit agencies, but does not provide sufficient detail to immediately implement these technologies.

Initially, each of the state's 23 rural and small urban transit agencies were assessed and categorized into four Transit Technology Profiles (TTP) based on needs and factors such as size and scope of operations, complexity of service delivery, and degree of service coordination.

The four levels are summarized as follows: Level 1 is the simplest with Level 4 the most involved.

Level 1 includes small agencies with primarily fixed route services and small service areas. Many of the small urban areas are in this category. Two technology applications are recommended, scheduling and vehicle maintenance software. The scheduling system would either be a "low end" commercial package, or a system adapted from office spreadsheet and database software.

Level 2 includes mid-sized regional agencies. Two technology applications are recommended: scheduling and vehicle maintenance software.

Level 3 includes most of the regional transit agencies. Three technology applications are recommended: scheduling, vehicle maintenance software, and data communications. The data communications component may utilize less costly delayed data communications, rather than real-time data communications.

Level 4 includes the largest regional systems. This level would add AVL to the Level 3 applications.

Phase IB Transit Agency Assessment

During Phase IB, the needs and opportunities for each transit agency were reviewed more closely. This more rigorous review included an evaluation of technology applications already in place, and an analysis of transit system characteristics.

Table 7.1 shows technology already in use around the state. As shown, the state's transit agencies already have some experience with technology. An important point in developing individual agency plans is to build on this experience. Table 7.1 also shows how each agency accomplishes functions that could be automated.

Table 7.2 shows an evaluation of the specific transit system characteristics that are important in determining the level of technology that may be cost effective. The factors that are used in this determination include the transit system's scale and scope, complexity of service delivery, and preference for technology use.

The information summarized in Tables 7.1 and 7.2 was compiled during the transit agency assessments and site visits conducted early in the project.

Table 7.1
Technology Currently in Use by Transit System

TTP	System	Location	Vehicle Maintenance	Reservations & Scheduling	Data Communications	AVL	Other
1	Burlington Urban System	Burlington	Maint. by DPW with automated system	Manual	None	None	
	Mason City Transit	Mason City	Maint. by DPW with automated system	Manual	None	None	
	Clinton	Clinton	None	Easy Rider software	None	None	
	Marshalltown MMT	Marshalltown	None	All manual	None	None	
	Muscatine Muscabus	Muscatine	No – maint. By DPW with system	Manual	None	None	
2	Reg. 16 Southeast Iowa	Burlington	None	All manual	None	None	
	Reg. 6 Peoplerides	Marshalltown	None	Has system adapted from database program.	None	None	
3	Reg. 1 NRTS	Decorah	Has system adapted from database program.	Has system adapted from database program.	None	None	
	Reg. 14 Southern Iowa	Creston	None	All manual	None	None	
	Reg. 7 Iowa Northland	Waterloo	Has system adapted from database program.	Manual	None	None	Uses GIS
	Reg. 2 North Iowa RTA	Mason City	None	None	None	None	
	Reg. 8 RTA	Dubuque	Automated system in place.	Uses CTS scheduling package.	None	None	Uses other database applications
	Reg. 11 HIRTA	Des Moines	Automated system in place.	All manual	None	None	
	Reg. 13 SWITA	Atlantic	None	All manual	None	None	
	Reg. 12 Western Iowa	Carroll	None	All manual	None	None	
4	Region 5 MIDAS/Ft. Dodge	Fort Dodge	Automated system in place, “Q-Quest”	“Mobility Manager” Software	None	None	MIDAS uses GIS
	Reg. 9 River Bend Transit	Davenport	Automated system in place, “CFA”	Uses DOS version of PTMS	None	None	Uses other computer
	Reg. 4 SRTS	Sioux City	None	Uses DOS version of PTMS	None	None	
	Reg. 3 RTA	Spencer	“Fleet-Mate”	Manual	None	None	
	Reg. 10 East Central Iowa	Cedar Rapids	None	Partial automation (Trapeze)	Partial	Partial	Some operators in brokered
	Reg. 15 Ottuma/10-15	Ottumwa	None	None current	Yes	Yes	Model deployment

Table 7.2
Assessment of Technology Factors by Transit System

TTP	System	Location	Scope & Scale	Complexity Factors	Service Coordination	Preference for Technology	Other Factors
1	Burlington Urban System	Burlington	Small	Fixed route		None	
	Mason City Transit	Mason City	Small	Fixed route	Potential with Reg. 2	Limited	
	Clinton	Clinton	Small				Service coordination possible.
	Marshalltown MMT	Marshalltown	Small	Fixed route & some DR	Potential with Reg. 6	Open	Limited exposure to Tech.
	Muscatine Muscabus	Muscatine	Small	Fixed route & some DR	Limited	Interested	Has GIS & has looked at sch.
2	Reg. 16 Southeast Iowa	Burlington	Medium, Decentralized	Mostly subscription trips, moderate contract revenue.	Potential	Open	
	Reg. 6 Peoplerides	Marshalltown	Small	Demand response, moderate contract revenue	Potential	Limited	Automation in place through adapting office software.
3	Reg. 1 NRTS	Decorah	Medium	Mostly subscription trips, moderate contract revenue.	Limited	Open	Interested in AVL for control. Poor radio coverage.
	Reg. 14 Southern Iowa	Creston	Medium	Mostly subscription trips, moderate contract revenue.	Limited	Open	Cell phones due to poor radio coverage.
	Reg. 7 Iowa Northland	Waterloo	Small	Demand response, significant contract revenue	Good potential	Yes	Has access to TransCAD software and Arc View GIS. Has requested funding for ITS in the past.
	Reg. 2 North Iowa RTA	Mason City	Large Brokered	Mostly subscription trips, moderate contract revenue.	Potential with Mason City	Limited	Operates ADA for Mason City.
	Reg. 8 RTA	Dubuque	Medium	Mostly subscription trips, moderate contract revenue.	Potential	Open	Comm. System requires upgrade.
	Reg. 11 HIRTA	Des Moines	Large Brokered	Decentralized operation, significant contract revenue.	Potential with MTA in Des Moines	Limited	Current decentralized operation reduces potential for tech.
	Reg. 13 SWITA	Atlantic	Large	Mostly subscription trips, moderate contract revenue.	Limited	Yes	Has requested funding for scheduling software.
	Reg. 12 Western Iowa	Carroll	Large	Demand response, significant contract revenue	Interested	Yes	

TTP	System	Location	Scope & Scale	Complexity Factors	Service Coordination	Preference for Technology	Other Factors
4	Reg. 5 MIDAS/Ft. Dodge	Fort Dodge	Large	Mostly subscription trips, moderate contract revenue. Fixed route and some DR in Ft. Dodge.	Coordination with Ft. Dodge	Yes	Currently uses scheduling software.
	Reg. 9 River Bend Transit	Davenport	Large	Demand response, significant contract revenue	Consolidation under study.	Yes	Operates ADA for both urban areas.
	Reg. 4 SRTS	Sioux City	Large & growth potential	Demand response, moderate contract revenue	Operates ADA paratransit for Sioux City.	Yes	Has funds for tech.
	Reg. 3 RTA	Spencer	Large & growth potential	Mostly subscription trips, moderate contract revenue.	Limited	Yes	Has funds for tech. And has tech. In place.
	Reg. 10 East Central Iowa	Cedar Rapids	Large Brokered	Demand response, moderate contract revenue	Significant potential	Yes, demonstrated	2 counties have AVL
	Reg. 15 Ottuma/10-15	Ottumwa	Large	Demand response, significant contract revenue	Operates urban and rural system	Yes, demonstrated	Operates urban and rural system

In order to develop priorities for technology deployment, these factors were used in a second level assessment of the transit agencies. Table 7.3 shows how the transit system characteristics were evaluated to produce a ranking of transit systems relative to technology deployment. This is a refinement of the *a priori* ranking used in Phase IA Transit Technology Profiles.

Table 7.3
Factors and Considerations for ITS Deployment

	Size & Scope		**Complexity**			**Other**	
Ranking	Fleet Size	Service Area	Service Type	Institutional & Funding	Operations	Coordination Potential	Technology Preference
5	Largest > 50	Largest 7+ counties	Mostly DR	Highly complex, many contracts	Single operator, centralized	Currently coordinated	Technology in place, funding available
4	Large 40 - 50	5 - 6 counties	Equal DR & sub.	Complex, high % contract revenue >50%	Single operator, Some decentralization	Good potential, willingness	Actively interested, some demonstration
3	Medium, 25 - 40	3 - 4 counties	Mostly subscription	Contract revenue <50%	Single operator, Decentralized operations	Potential	Open
2	Small >25	2 counties or less	Fixed w/ limited DR	Few contracts	Brokered few operators	Limited potential	Limited interest
1	Smallest <15	City only	Fixed Route	Single source funding	Brokered, many contractors	No interest	No interest
Weight	**5**	**5**	**5**	**3**	**2**	**4**	**4**

Size and Scope are straightforward. The size of the fleet was used as a measure of the system size, and the extent of the service area was used as a measure of scope. “Complexity” was measured in three ways. Recognizing that demand response (DR) service is more complex than subscription service, and both are more complex to operate than fixed route, the approximate portion of service in each category was used in the rankings. The level of funding obtained through contracts with other agencies dictates the complexity of record keeping and reporting for reimbursements. Finally, the degree of centralization is a factor in having effective technology deployment. The “Other” factors deal with the agency’s experience with technology, and their preference in becoming involved with technology applications.

Each agency was ranked on a scale of 1 to 5 for each of the seven factors. The factors were assigned weights reflecting the factor’s relative importance in determining deployment priorities. These weights are shown in the last row in Table 7.3. In this manner, “Size & Scope” and “Complexity” are of equal weight (36% of the total apiece), and “Other” factors account for 18% of the total.

Table 7.4 shows how each agency was scored with the factors in Table 7.3. Some of the ratings are objective (e.g., fleet size), but others are subjective. Therefore, these ratings were reviewed by the Steering Committee, and distributed to each transit agency for review.

Table 7.4
Transit System Ratings – ITS Deployment Factors

Transit System	Size & Scope		Complexity			Other	
	Fleet Size	Service Area	Service Type	Institutional & Funding	Operations	Coordination Potential	Technology Preference
Mason City Transit	1	1	1	1	5	3	3
Burlington Urban System	1	1	2	1	5	3	1
Clinton	1	1	2	1	5	3	3
Marshalltown MMT	1	1	2	1	5	3	3
Muscatine Muscabus	1	1	2	1	5	2	4
Region 11 HIRTA	5	5	3	4	2	3	2
Region 2 North Iowa RTA	5	5	3	3	1	3	2
Region 10 East Central Iowa	5	4	5	3	2	5	5
Region 1 NRTS	4	4	3	3	4	2	3
Region 5 MIDAS/FT. Dodge DART	5	4	3	3	4	5	4
Region 6 Peoplerides	2	3	4	3	5	3	2
Region 7 Iowa Northland	2	4	3	4	3	4	4
Region 8 RTA	3	3	4	4	4	3	4
Region 9 River Bend Transit	5	3	4	5	5	4	3
Region 12 Western Iowa	5	4	4	5	3	2	3
Region 13 SWITA	5	5	3	3	3	2	4
Region 14 Southern Iowa	3	5	3	3	4	2	3
Region 15 Ottumwa/10-15	5	5	4	4	5	5	5
Region 16 Southeast Iowa	2	3	3	2	3	3	3
Region 3 RTA	5	5	4	5	5	2	4
Region 4 SRTS	5	4	4	3	4	5	4
Weight	**5**	**5**	**5**	**3**	**2**	**4**	**4**

The result of this evaluation is shown in Table 7.5. These are the revised technology categories that were used for the development of the Iowa Statewide Transit ITS Deployment Plan.

Table 7.5
Revised Technology Categories

Transit System	Score	Technology Category
Burlington Urban System	49	**Level 1 Limited Deployment**
Mason City Transit	52	
Clinton	57	
Marshalltown MMT	57	
Muscatine Muscabus	57	
Region 16 Southeast Iowa	76	**Level 2 Limited Deployment**
Region 6 Peoplerides	84	
Region 1 NRTS	92	**Level 3 Mid-Level Deployment**
Region 14 Southern Iowa	92	
Region 7 Iowa Northland	95	
Region 2 North Iowa RTA	96	
Region 8 RTA	98	
Region 11 HIRTA	101	
Region 13 SWITA	104	
Region 12 Western Iowa	106	
Region 5 MIDAS/DART	113	**Level 4 "Full" Deployment**
Region 9 River Bend Transit	113	
Region 4 SRTS	118	
Region 3 RTA	119	
Region 10 East Central Iowa	123	
Region 15 Ottumwa/10-15	132	

The revised technology categories are similar to the initial categories, except that four additional transit agencies were included in category 4.

The deployment of individual technologies for transit agencies in each category would be the same as the deployment plan from Phase IA.

- Category 1 agencies would have vehicle maintenance software and a low-end transit operations package.
- Category 2 would have vehicle maintenance software and a low-end to moderate transit operations package.
- Category 3 would have vehicle maintenance software, a high-end transit operations package, and data communications.
- Category 4 would include all of the applications in Category 3 and AVL.

Agency Implementation Costs

The cost of implementing these technologies is an important consideration, from a state perspective, and perhaps more so from an individual agency perspective.

Table 7.6 shows the initial cost of the deployment of this level of technology.

Table 7.6
Initial ITS Deployment Costs

System	Vehicle Maintenance Software	Transit Operations Software	Data Communication & MDTs	AVL	Agency Totals
Burlington Urban System		$ 72,000			$ 72,000
Mason City Transit	$ 2,000	$ 72,000			$ 74,000
Clinton	$ 2,000				$ 2,000
Marshalltown MMT	$ 2,000	$ 72,000			$ 74,000
Muscatine Muscabus		$ 72,000			$ 72,000
Region 16 Southeast Iowa	$ 2,000	$ 82,000			$ 84,000
Region 6 Peoplerides	$ 2,000				$ 2,000
Region 1 NRTS		$ 84,000	$ 242,000		$ 326,000
Region 14 Southern Iowa	$ 4,000	$ 84,000	$ 215,000		$ 303,000
Region 7 Iowa Northland		$ 72,000	$ 132,000		$ 204,000
Region 2 North Iowa RTA	$ 5,000	$ 108,000	$ 457,000		$ 570,000
Region 8 RTA		$ 84,000	$ 176,000		$ 260,000
Region 11 HIRTA	$ 5,000	$ 108,000	$ 479,000		$ 592,000
Region 13 SWITA	$ 4,000	$ 96,000	$ 308,000		$ 408,000
Region 12 Western Iowa	$ 4,000	$ 96,000	$ 363,000		$ 463,000
Region 5 MIDAS/Ft. Dodge		$ 94,000	$ 352,000	$ 185,000	$ 631,000
Region 9 River Bend Transit		$ 106,000	$ 319,000	$ 183,000	$ 608,000
Region 4 SRTS	$ 4,000	$ 94,000	$ 253,000	$ 178,000	$ 529,000
Region 3 RTA		$ 118,000	$ 402,000	$ 189,000	$ 709,000
Region 10 East Central Iowa	$ 4,000		$ 457,000	$ 187,000	$ 648,000
Region 15 Ottumwa/10-15	$ 4,000	$ 94,000			$ 98,000
Statewide Totals	**$ 44,000**	**$ 1,608,000**	**$ 4,155,000**	**$ 922,000**	**$ 6,729,000**

=system already in place
=system not recommended

As shown in Table 7.6, the total initial cost for statewide deployment is estimated at $6.7 million for the five year plan.

Deployment costs could be reduced significantly through the use of alternative technology that has most, but not all of the capabilities associated with the high-end applications. For example, the smaller agencies would realize benefits from a reservations and scheduling system adapted from database and spreadsheet programs, at a fraction of the cost of commercial packages. TTP category 3 transit agencies can gain many of the benefits of real-time data communications with delayed data communications, at about a third of the cost.

Table 7.7 shows the initial cost of statewide deployment using these lower cost alternatives.

Table 7.7
Initial ITS Deployment Costs – Reduced Technology Cost Option

System	Vehicle Maintenance Software	Transit Operations Software	Data Communication & MDTs	AVL	Agency Totals
Burlington Urban System		$ 10,000			$ 10,000
Mason City Transit	$ 2,000	$ 10,000			$ 12,000
Clinton	$ 2,000				$ 2,000
Marshalltown MMT	$ 2,000	$ 10,000			$ 12,000
Muscatine Muscabus		$ 10,000			$ 10,000
Region 16 Southeast Iowa	$ 2,000	$ 20,000			$ 22,000
Region 6 Peoplerides	$ 2,000				$ 2,000
Region 1 NRTS		$ 84,000	$ 64,000		$ 148,000
Region 14 Southern Iowa	$ 4,000	$ 84,000	$ 59,000		$ 147,000
Region 7 Iowa Northland		$ 72,000	$ 44,000		$ 116,000
Region 2 North Iowa RTA	$ 5,000	$ 108,000	$ 103,000		$ 216,000
Region 8 RTA		$ 84,000	$ 52,000		$ 136,000
Region 11 HIRTA	$ 5,000	$ 108,000	$ 107,000		$ 220,000
Region 13 SWITA	$ 4,000	$ 96,000	$ 76,000		$ 176,000
Region 12 Western Iowa	$ 4,000	$ 96,000	$ 86,000		$ 186,000
Region 5 MIDAS/Ft. Dodge		$ 94,000	$ 352,000	$ 185,000	$ 631,000
Region 9 River Bend Transit		$ 106,000	$ 319,000	$ 183,000	$ 608,000
Region 4 SRTS	$ 4,000	$ 94,000	$ 253,000	$ 178,000	$ 529,000
Region 3 RTA		$ 118,000	$ 402,000	$ 189,000	$ 709,000
Region 10 East Central Iowa	$ 4,000		$ 457,000	$ 187,000	$ 648,000
Region 15 Ottumwa/10-15	$ 4,000	$ 94,000			$ 98,000
Statewide Totals	**$ 44,000**	**$ 1,298,000**	**$ 2,374,000**	**$ 922,000**	**$ 4,638,000**

=system already in place
=system not recommended

This approach reduces the total cost by over $2 million to $4.6 million. These costs were used in the development of the preliminary individual agency plans. It is recommended that Iowa DOT base the project financing on the cost levels shown in Table 7.7.

In addition to the initial costs of technology, these applications have an ongoing cost component for operations and maintenance. Operating costs include annual staff salaries and benefits, rent and maintenance of facilities, general overhead expenses, and shared costs with other transit ITS projects. Maintenance costs include annual repair, upgrade, and support costs for hardware, software, and operational facilities. Since the exact operating and maintenance costs are not known for most transit ITS systems, these costs are estimated as a percentage of the capital costs, using 10% and 8%, respectively. As previously explained, these percentages have been used in transit ITS planning to provide an idea of the magnitude of the ongoing costs.

Table 7.8 shows the operating and maintenance costs associated with the technology deployment summarized in Table 7.7.

Table 7.8
Annual Operating and Maintenance Costs – Reduced Technology Cost Option

System	Vehicle maintenance software	Transit Operations Software	Data Communication & MDTs	AVL	Agency Totals
Burlington Urban System		$ 2,000			$ 2,000
Mason City Transit	$ 400	$ 2,000			$ 2,400
Clinton	$ 400				$ 400
Marshalltown MMT	$ 400	$ 2,000			$ 2,400
Muscatine Muscabus		$ 2,000			$ 2,000
Region 16 Southeast Iowa	$ 400	$ 4,000			$ 4,400
Region 6 Peoplerides	$ 400				$ 400
Region 1 NRTS		$ 15,000	$ 12,000		$ 27,000
Region 14 Southern Iowa	$ 700	$ 15,000	$ 11,000		$ 26,700
Region 7 Iowa Northland		$ 13,000	$ 8,000		$ 21,000
Region 2 North Iowa RTA	$ 900	$ 19,000	$ 19,000		$ 38,900
Region 8 RTA		$ 15,000	$ 9,000		$ 24,000
Region 11 HIRTA	$ 900	$ 19,000	$ 19,000		$ 38,900
Region 13 SWITA	$ 700	$ 17,000	$ 14,000		$ 31,700
Region 12 Western Iowa	$ 700	$ 17,000	$ 15,000		$ 32,700
Region 5 MIDAS/Ft. Dodge		$ 17,000	$ 63,000	$ 33,000	$ 113,000
Region 9 River Bend Transit		$ 19,000	$ 57,000	$ 33,000	$ 109,000
Region 4 SRTS	$ 700	$ 17,000	$ 46,000	$ 32,000	$ 95,700
Region 3 RTA		$ 21,000	$ 72,000	$ 34,000	$ 127,000
Region 10 East Central Iowa	$ 700		$ 82,000	$ 34,000	$ 116,700
Region 15 Ottumwa/10-15	$ 700	$ 17,000			$ 17,700
Statewide Totals	**$ 8,000**	**$ 233,000**	**$ 427,000**	**$ 166,000**	**$ 834,000**

=system already in place
=system not recommended

Transit agencies must prepare for these expenses during planning for technology deployment. Some of these costs may already be incurred by the agency, for example staff salaries that are included in operations. There is likely to be a redirecting of staff resources with the incorporation of technology into an agency's business practices. In addition, some of these costs can be "capitalized" and incorporated into the initial cost of the project. An example of this is the cost of annual maintenance preformed by the vendor to supper the application. It is typical that three years (or more) of annual vendor support is included in the cost of system acquisition.

Individual Agency Plan Preparation and Project Development

Preliminary Agency Technology Deployment Plans were prepared for each transit agency based on the information and conclusions presented in the preceding sections of this report. The preliminary plans include the recommended applications, initial and operating costs, proposed schedule and timing, and a brief assessment of benefits. The Preliminary Plans are included in an appendix to this report.

The general conclusions and recommendations for each transit agency should be revisited during the preparation of a more detailed individual Agency Technology Plan. These Agency Plans will include more involvement and input from the transit system manager. The Initial Transit System Assessment should be reviewed to document in detail workflows, current systems and infrastructure, and define system reporting and invoicing requirements.

There is also an opportunity to determine each transit agency's needs and expectations specifically. The process should identify specific technologies for at least five years into the future to address the findings of the assessment. A financing component should be part of the Agency Technology Plan.

The Agency ITS Plan will include specific ITS applications, interfaces, costs and funding, staging and schedule. The plan should also include provisions for ongoing technical support and documentation that it is in compliance with regional and statewide ITS architecture. A key product is a functional requirements document that will be used as the basis for the specification used to procure the ITS system or product. The Agency Plan can be used as part of the application for funding at the state and federal level.

It is recommended that agencies in TTP categories 3 and 4 prepare a formal Technology Plan. This is warranted for agencies contemplating the expenditure of several hundred thousand dollars for technology enhancements. Smaller agencies need not prepare a formal plan, but should review the recommendations of this report carefully, and affirm the plan's recommendations for the agency.

8.0
NEXT STEPS

The Statewide Transit ITS plan provides general plans for the deployment of ITS applications in the state's small urban and rural transit agencies. The Statewide plan provides a very good starting point for these transit agencies, but does not provide sufficient detail to immediately implement these technologies.

The following outline identifies the tasks and activities required to implement specific ITS projects in a transit agency. These activities are part of Phase II of the Iowa Transit ITS Deployment Project.

Individual Agency Plan Preparation and Project Development

- Review Initial Transit System Assessment: This is to refine the conclusions of the initial site assessment performed in early 2002 and document in detail workflows, current systems and infrastructure, and define system reporting and invoicing requirements.

- Determine Transit Agency's Needs and Expectations: Identify specific technologies for at least five years into the future to address the findings of the assessment. The Preliminary Plans developed as part of these projects should be used as a starting point, but more involvement and input from agency staff is required. The planning process should include interviews with operating staff and observations of staff functions. Opportunities for agency and service coordination should also be explored.

- Prepare Agency Specific ITS Plan: The plan will include specific ITS applications, interfaces, costs and funding, staging and schedule. The plan should also include provisions for ongoing technical support and documentation that it is in compliance with regional and statewide ITS architecture. A key product is a functional requirements document that will be used as the basis for the specification used to procure the ITS system or product. The Agency Plan can be used as part of the application for funding at the state and federal level. Transit agencies in TTP levels 3 and 4 should prepare formal ITS deployment plans because on the magnitude of the investment being contemplated. Agencies in TTP categories 1 and 2 do not require a formal process.

As part of project development the Agency Plan should be submitted for approval at the local level, and submitted for funding at the state, and possibly, federal level.

- The Agency Plan is submitted to the governing body of the transit agency for review and approval. Plan approval should include authorization to pursue state and federal funding for the plan.

- The Agency Plan is submitted to Iowa DOT for consideration for state ITS funding, and federal funding. The plan should be evaluated based on consistency with the Statewide Transit ITS Deployment Plan, particularly the project evaluation criteria developed during the project.

- If applicable, Iowa DOT can include the project in any joint procurement program.

Specifications Development

A functional or performance specification suitable to solicit proposals from qualified vendors must be prepared. The specification should be based on the Agency Plan and the functional requirements previously developed during the planning process.

Procurement

- Preparation of RFP: The functional specification will be “packaged” in an RFP suitable for distribution to vendors. The RFP should include agency requirements, procurement process information, schedules and selection criteria.

- Solicitation: To include identification of qualified vendors, advertisement, a pre-proposal conference, response to proposer’s questions, specification clarifications and addendums.

- Award: To include the review and evaluation of proposals, and recommendation of the most responsive vendor, leading to the issuance of a notice to proceed.

Installation and Project Management

- Vendor Oversight: To include contracting and vendor initialization, and management of the vendor’s activities throughout the course of the project, including review/acceptance of invoices and acceptance of work products.

- Operating Procedure Revisions: Including assistance with the revision of work processes with the introduction of technology and documentation of procedures.

- Installation: Oversight of the installation of system hardware and software.

- Training: Coordination of training provided by the vendor.

System Testing

- Testing: Management of the system testing process, including review and/or preparation of a testing plan, and oversight of the testing process.

- Acceptance: Recommendation of system acceptance.

APPENDIX

Preliminary Transit Agency Technology Deployment Plans