Intelligent Transportation Systems Deployment Plan
Large Urban Transit Systems

Final Report

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SNYDER & ASSOCIATES

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ABBREVIATIONS AND ACRONYMS

ADA	Americans with Disabilities Act
APC	Automatic Passenger Counter
APTS	Advanced Public Transportation Systems
ATIS	Advanced Traveler Information Systems
ATMS	Advanced Traffic Management Systems
AVL	Automatic Vehicle Location
AVSS	Advanced Vehicle Safety Systems
BAFO	Best And Final Offer
CAD	Computer-Aided Dispatch
CCTV	Closed Circuit Television
CDPD	Cellular Digital Packet Data
CMAQ	Congestion Mitigation and Air Quality Improvement Program
DART	Des Moines Area Regional Transit Authority
DOT	Department of Transportation
DMS	Dynamic Message Sign
EDACS	Enhanced Digital Access Communications System
EPS	Electronic Payment System
FHWA	Federal Highway Administration
FST	Five Seasons Transportation
FTA	Federal Transit Administration
FTE	Full-Time Equivalent
GH_Z	Giga Hertz
GPS	Global Positioning System
ICAAP	Iowa Clean Air Attainment Program
ICT	Iowa City Transit
IFB	Invitation for Bid
IP-VPN	Internet Protocol – Virtual Private Network
ISP	Internet Service Provider
ITP	Interurban Transit Partnership
ITS	Intelligent Transportation Systems

IVI	Intelligent Vehicle Initiative
IVR	Interactive Voice Response System
JARC	Job Access and Reverse Commute Formula Grants
Kbps	Kilo bits per second
KH_Z	Kilo Hertz
MB	Megabit
Mbps	Mega bits per second
MH_Z	Mega Hertz
MDT	Mobile Data Terminal
MMIS	Maintenance Management Information System
NHS	National Highway System
NTP	Notice To Proceed
OPT	Office of Public Transit
PDA	Personal Digital Assistant
RF	Radio Frequency
RFP	Request For Proposals
RSA	Route and Schedule Adherence
SIB	State Infrastructure Banks
STP	Surface Transportation Program
TCP	Transfer Connection Protection
TCSP	Transportation Community and System Preservation Program
TIS	Telephone Information System
TSP	Transit Signal Priority
USDOT	United States Department Of Transportation
VCM	Vehicle Component Monitoring System
VHF	Very High Frequency
UHF	Ultra High Frequency
WLAN	Wireless Local Area Network

Summary

The Intelligent Transportation Systems (ITS) Deployment Plan for Large Urban Transit Systems is a road map that will assist the large urban transit systems in Iowa in improving their services through the use of ITS technologies. ITS technologies are hardware and software systems that can increase the efficiency and safety of public transportation and offer users better information on system operations. The implementation of ITS has been transforming the way public transportation systems operate. One of the key benefits of ITS is providing public transportation decision-makers with more information with which they can make decisions regarding improving operations, increasing ridership and improving customer service.

In early 2006, the Iowa Department of Transportation engaged TranSystems to assist in the development of a statewide ITS deployment plan for Iowa's large urban transit systems. This project examined the needs and opportunities related to the expanded deployment of ITS applications by the state's urban transit agencies.

The purpose of this ITS Deployment Plan is to identify technologies that are recommended for implementation; describe their characteristics, costs and benefits; identify resources and training requirements; and define preliminary implementation timeframes. The Deployment Plan contains information that can be used to:

- Determine whether technology is needed, and if so, what kinds of technologies;
- Determine and/or validate the appropriate "phasing" of various technologies;
- Facilitate management understanding on technology;
- Understand the use of technology in the transit system;
- Plan the specifications development processes;
- Initially determine resource requirements (e.g., operations, maintenance, administration);
- Determine the impact on the organization(s) and employees, and plan to manage these impacts;
- Assist Iowa DOT and agencies in securing ITS funding through grants and earmarks;
- Plan for initial and full deployment of multiple technologies; and
- Plan for project evaluations.

Several important steps and processes were used to accomplish the required tasks for this project. One of these steps included a Systems Engineering Analysis, which is required as part of the Federal Transit Administration (FTA) National ITS Architecture Policy on Transit Projects. This analysis process included the TranSystems Team visiting every urban transit agency that took part in this study, and interviewing their staff and collecting essential data and information. This provided the TranSystems Team with an in-depth understanding of each agency's needs, issues and internal processes. A comprehensive review of agencies' communications systems was also conducted, as was a review of existing ITS technologies. Recent studies and agencies' future plans were also reviewed and considered as part of the analysis.

Based on the analysis, specific technologies were recommended for each agency. The costs, preliminary deployment timelines, and the impacts on agencies of each technology were defined in this project.

S-1. Participating Transit Agencies

Out of the 12 large urban transit systems that provide transit services throughout the state of Iowa, 11 participated in this project. The urban transit systems are shown in Table S-1.

Table S-1. Large Urban Transit Systems

City	Agency
Sioux City	Sioux City Transit
Waterloo	Metropolitan Transit Authority of Black Hawk County
Dubuque	Keyline Transit
Bettendorf	Bettendorf Transit
Davenport	CitiBus
Cedar Rapids	Five Seasons Transportation
Coralville	Coralville Transit
Iowa City	Iowa City Transit
Iowa City	University of Iowa, Cambus
Ames	CyRide
Des Moines	Des Moines Area Regional Transit Authority
Council Bluffs	Omaha Metro Area Transit

Council Bluffs did not participate because their transit service is provided by Omaha MAT and MAT has an ITS system in place. Bettendorf's participation was minimal because they are currently implementing transit ITS as part of the City's traffic program.

The project was led by a Steering Committee comprised of the individuals shown in Table S-2.

Table S-2. Members of the Steering Committee

Name	Agency
Bob Krause	Iowa DOT- Public Transit
Peter Hallock	Iowa DOT- Public Transit
Matthew Simaytis	City of Bettendorf
Mark Little	Black Hawk County
Vicky Robrock	Coralville Transit
Sheri Kyras	CyRide
Pete Donner	Davenport CitiBus
Brad Miller	Des Moines Area Regional Transit Authority
Jon Rodocker	City of Dubuque- Keyline Transit
Bill Hoekstra	Five Seasons Transportation & Parking
Ron Logsden	Iowa City Transit
Curt Miller	Sioux City Transit
Brian McClatchey	University of Iowa

S-2. Identified Needs

The main objective of this study is to assess and plan for transit ITS technology applications for urban transit systems, using solutions that have been shown to improve the efficiency and effectiveness of transit services in other transit agencies. Hence, an understanding of each of these agencies' needs was vital for the completion of this study. The following is a summary of the overall needs assessment.

<u>Operations:</u> Agencies have expressed a need to know the exact location of their vehicles at any particular moment to better manage their fleet and to better answer customer inquiries on where their vehicles are.

Further, on-time performance is currently monitored by street supervisors, or not at all. There appears to be a need to automate this process to provide more complete and reliable on-time performance data.

<u>Scheduling:</u> At most of the participating agencies, route schedules are developed manually using spreadsheet software. This is a very tedious and time consuming task, and may not produce the most efficient schedules. There is a need to automate that process through the use of specialized scheduling software.

<u>Planning:</u> One of the most valuable data to a planning department is ridership data which is used in planning new services as well as modifying existing routes. Almost all of the agencies in this study are currently dependent on manual collection of ridership data. This makes the data prone to errors. Further, the process of collecting, entering and analyzing the data is usually very long. There is an obvious need, for almost all of these agencies, to collect ridership data in a timely manner, and to improve its reliability and accuracy. This data is also used in meeting federal reporting requirements such as the National Transit Database.

<u>Customer Service:</u> For many of the agencies taking part in this project, the volume of service information calls has increased substantially in recent years and have become somewhat of a burden to the personnel who take these calls. Hence, there is a need to provide as much of the requested information to customers in real-time on the Internet or at bus stops. The provision of real-time information would keep customers apprised of bus arrival/departure times.

Moreover, agencies are very much interested in increasing their ridership which translates into greater revenues. Deploying web based information has the potential to attract more ridership as it makes finding transit information much easier and user friendly.

Additionally, one of the critical issues for most agencies is complying with the Americans with Disabilities Act (ADA) requirement for making next-stop announcements on board buses. In order to comply with this requirement, these announcements can be automated, as not all drivers are currently making all the announcements.

<u>Security:</u> Some agencies have portions of their fleet equipped with onboard cameras. Onboard cameras are becoming more and more critical for transit agencies as they provide a greater sense of security to the drivers and passengers. Further, they have been playing a role in dismissing fraudulent lawsuits.

Finance: Some agencies are still using cash boxes for collecting fares while electronic fareboxes at the other agencies are outdated and do not meet the agencies' needs. Some of the existing issues include a lack of accurate fare data, fare evasion, and high collection and handling costs. There is a need to deploy the next generation fareboxes capable of tracking fares and using electronic fare media.

Maintenance: About half of the participating agencies are in need of maintenance management software that can interface with their financial system. Maintenance software will enable the agencies to better track their maintenance activities, reduce the cost of maintenance and inventory, schedule preventive maintenance, and collect required data for internal use as well as for federal reporting.

Communications: Although voice radio communication systems do not seem to be a problem for most of the agencies, there is a real deficit in data communications. In the past, a simple voice radio communications system was usually sufficient to support most agencies, but the evolution of ITS technologies and on-board mobile data terminals (MDTs) have added a need for mobile data communications. All participating agencies will require a data communication system. A cellular option may be the best technology for most agencies. Commercial cellular carriers offer rapid implementation, higher bandwidth, low cost monthly rate plans, low cost equipment, reliable service, low maintenance costs, good coverage in urban areas and along major highways, and the ability for multiple agencies to operate on a common system if desired.

S-3. Recommended Technologies

The following paragraphs provide a summary of each of the recommended ITS technology.

Scheduling Software: Fixed route scheduling and daily operations management software applications help transit agencies with route planning and restructuring, runcutting, operator scheduling, and vehicle assignments. Increasingly, scheduling software products are being integrated with other technologies (e.g., automatic vehicle location) for additional benefits.

AVL/CAD: Automatic vehicle location (AVL) systems determine the location of vehicles that are equipped with specific hardware and software. Central dispatch can view the equipped vehicles' locations on a map, in addition to displaying specific information about each vehicle. An AVL system serves as the backbone to many transit ITS applications such as automatic annunciation, vehicle component monitoring, automatic passenger counting (APC), and transit signal priority (TSP) systems.

Transit agencies use Computer-Aided Dispatch (CAD) systems for bus service and operations management. A number of transit agencies and their vendors have implemented or are developing modules that will expand the capabilities of vehicle location and dispatch systems to provide data for other agency functions.

Mobile data terminals (MDTs), which are typically located in each vehicle near the driver, are an integral aspect of a CAD/AVL system since they facilitate data transfer between the vehicle and operations/dispatch. MDTs usually have a small screen that displays text and/or graphics, along with a keypad that contains either pre-coded keys (e.g., pick-up/drop-off, request to talk, maintenance incident) or "soft" keys that can be flexibly programmed.

Maintenance Management Software: Maintenance management software is designed for supporting vehicle, infrastructure and facility maintenance. The software usually supports corrective and preventive maintenance, inspections, overhauls, and campaigns. It also identifies and tracks vehicles and serialized components; identifies, plans, schedules, and tracks work; collects maintenance histories and costs; analyzes maintenance performance and manages equipment configuration. Some systems include a warranty module that identifies warranty terms, condition notification, claims processing, and payment processing.

On-board Cameras: On-board cameras monitor and record the passenger environment on-board transit vehicles. Cameras are usually mounted to provide complete coverage of the bus interior, and can be mounted to view door wells as well as the road through the front windshield.

Advanced Traveler Information Systems: Advanced Traveler Information Systems (ATIS) provide information to help travelers make decisions regarding their trips. This information generally includes: transit service areas and routes; scheduled vehicle departure times; projected vehicle arrival/departure times (through AVL); service disruptions and delays; fares, transfers and other transportation services; as well as information on the service area. This information is used to assist riders in making pre-trip and en-route (including in-vehicle) trip and mode choice decisions. Access to this information can be made through dynamic message signs (DMS) at stops/stations, kiosks (at bus shelters, office buildings, shopping centers and other locations such as a convention center and arenas), the Internet, e-mail, and phone.

Electronic Payment Systems: Electronic payment systems (EPS) make fare payment more convenient for the transit rider and financial management of fare revenues more secure and efficient for the transit agency. Electronic fare payment technologies include magnetic strip and contactless smart cards, which can be used as stored value cards or timed passes. EPS reduces cash handling, which is a labor-intensive activity, and improves the security of transit fare revenue EPS also facilitates the development of more innovative and equitable fare structures, and provides increased convenience to transit riders in the purchase and payment of transit fares.

Vehicle Component Monitoring Systems: A vehicle component monitoring system uses sensors to monitor the “health” of vital bus components, such as the engine, and reports when their performance is not within a specific tolerance. By keeping track of these components, supervisors and maintenance personnel can use this information to intervene before a minor problem becomes more substantial.

Table S-3 on the following page provides a summary of the recommended technologies by agency.

Table S-3. Summary of Recommended (✔) and Existing (E) Technologies

Agency	Recommended Technology											
	CAD/AVL	APC	ATIS (web)	ATIS (itinerary planning)	ATIS (at stop)	Automatic Annunciation	Electronic Payment System (EPS)	Maintenance Management System	On-Board Cameras	Scheduling Software	Vehicle Component Monitoring System	Driving Simulator
Sioux City Transit	✔	✔			✔	✔	✔	✔	E	✔		
MET Waterloo	✔	✔				✔	✔	E				
Keyline Dubuque	✔	✔				✔	✔	✔	✔			
Bettendorf Transit	***								***			
CitiBus Davenport	✔		✔			✔	✔	E	✔			✔
FST-Cedar Rapids		✔	✔	✔		✔	E	E	E	✔	✔	
Coralville Transit	✔		✔		✔		✔	✔	E			
Iowa City Transit	✔	✔		✔	✔	E	✔	✔	✔			
Cambus–U of Iowa	✔	✔	***		✔				E	✔		✔
CyRide - Ames	✔	✔	✔		✔	✔	✔	E	E			
DART–Des Moines	✔	✔		✔	✔	✔	✔	✔	✔	E		

*** Agency is planning on deploying that system in the near future.

S-4. Anticipated Cost Estimates and Deployment Timeframe

Most of the recommended ITS technologies cannot be deployed without having an operational CAD/AVL system. Although the deployment of the rest of the recommended ITS technologies are independent from one another, deploying two or more technologies at the same time can be more cost-effective and can shorten the overall deployment schedule. However, it is recommended that only a few systems be deployed at the same time, as it increases the risk of completing the project on-time and within budget. Hence, we recommend that the technologies be grouped into phases to better manage their deployments. Deployments are grouped into three (3) phases: Phase 1, which is one to three years; Phase 2, which is three to five years; and Phase 3, which is over five years.

The following tables provide a summary of the recommended ITS technologies and expected capital costs of the leased wireless mobile data option. Table S-4 summarizes the costs by phase of deployment and agency, while Table S-5 summarizes the costs by technology.

Table S-4. Summary of Total Cost of ITS Technologies and Leased Wireless Mobile Data

Phase/Agency	Recommended Technology		
	Cost of ITS Technologies	Cost of Communications System	Total Cost
Phase 1 (1-3 years)			
Sioux City Transit	$1,718,000	$34,760	$1,752,760
MET Waterloo	$340,000	$23,700	$363,700
Keyline - Dubuque	$763,000	$18,960	$781,960
Bettendorf Transit	$0	$64,780	$64,780
CitiBus - Davenport	$778,000	$31,600	$809,600
FST-Cedar Rapids	$0	0	$0
Coralville Transit	$564,000	$17,380	$581,380
Iowa City Transit	$654,000	$36,340	$690,340
Cambus – Univ. of Iowa	$810,000	$36,340	$846,340
CyRide - Ames	$1,533,000	$99,540	$1,632,540
DART – Des Moines	$2,295,000	$186,440	$2,481,440
Subtotal—Phase 1	***$9,455,000***	***$549,840***	***$10,004,840***
Phase 2 (3-5 years)			
Sioux City Transit	$125,000	$0	$125,000
MET Waterloo	$547,000	$0	$547,000
Keyline - Dubuque	$507,000	$0	$507,000
Bettendorf Transit	$0	$0	$0
CitiBus - Davenport	$1,021,000	$0	$1,021,000
FST-Cedar Rapids	$355,000	$0	$355,000
Coralville Transit	$410,000	$0	$410,000
Iowa City Transit	$578,000	$0	$578,000
Cambus – Univ. of Iowa	$125,000	$0	$125,000
CyRide - Ames	$1,371,000	$0	$1,371,000
DART – Des Moines	$266,000	$0	$266,000
Subtotal—Phase 2	***$5,305,000***	**$0**	***$5,305,000***
Phase 3 (Over 5 years)			
Sioux City Transit	$265,000	$0	$265,000
MET Waterloo	$205,000	$0	$205,000
Keyline - Dubuque	$0	$0	$0
Bettendorf Transit	$0	$0	$0
CitiBus - Davenport	$0	$0	$0
FST-Cedar Rapids	$0	$0	$0
Coralville Transit	$215,000	$0	$215,000
Iowa City Transit	$462,000	$0	$462,000
Cambus – Univ. of Iowa	$500,000	$0	$500,000
CyRide - Ames	$0	$0	$0
DART – Des Moines	$2,755,000	$0	$2,755,000
Subtotal – Phase 3	***$4,402,000***	**$0**	***$4,402,000***
Grand Total	**$19,162,000**	**$549,840**	**$19,711,840**

Table S-5. Summary of Technology Cost for All Large Urban Transit Systems

Recommended Technologies	Phase 1 (1-3 years)	Phase 2 (3-5 years)	Phase 3 (over 5 years)	Total By Technology
CAD/AVL	*$5,296,000*	*$458,000*	*$0*	**$5,754,000**
APC	*$592,000*	*$174,000*	*$97,000*	**$863,000**
ATIS (web)	*$81,000*	*$217,000*	*$0*	**$298,000**
ATIS (itinerary planning)	*$91,000*	*$146,000*	*$0*	**$237,000**
ATIS (at stop)	*$0*	*$785,000*	*$0*	**$785,000**
Automatic Annunciation	*$1,165,000*	*$180,000*	*$950,000*	**$2,295,000**
Electronic Payment System (EPS)	*$840,000*	*$2,630,000*	*$2,010,000*	**$5,480,000**
Maintenance Management System (MMIS)	*$520,000*	*$215,000*	*$695,000*	**$1,430,000**
On-Board Cameras	*$570,000*	*$0*	*$150,000*	**$720,000**
Scheduling Software	*$300,000*	*$0*	*$0*	**$300,000**
Driving Simulator	*$0*	*$500,000*	*$500,000*	**$1,000,000**
Communications	*$549,840*	*$0*	*$0*	**$549,840**
Total By Phase	***$10,004,840***	***$5,305,000***	***$4,402,000***	**$19,711,840**

S-5. Program Funding

A specific funding program has not been developed for the Urban Transit ITS program at this point. The Urban Transit ITS Deployment Plan will be used to secure program funding. Transit ITS projects are eligible for federal funding through several programs. Typically in the transit industry ITS projects are funded through a combination of federal funding, state funding (where available) and local funding.

The final report presents a discussion of the potential funding sources that should be considered in funding the implementation of the Urban Transit ITS Deployment Plan.
The Steering Committee has identified several important conclusions that must be considered as part of the funding program.

- It is likely that most of the transit will be unable to implement the recommended ITS technologies without 80 percent funding from non-local sources.
- A goal of securing 80 percent funding from federal sources should be established. This may be accomplished through a mix of funding programs.
- It is acknowledged that traditional federal funding sources such as 5309 discretionary funding is limited and other needs, such as bus replacement, will likely be a higher priority.
- The state is supportive of the Urban Transit ITS Deployment Plan project and will contribute funding as the state is able to identify available funding. It is acknowledged that state funding for transportation projects is limited, and very competitive.

- Because of transit's important role in Homeland Security – related strategies security related funding should be pursued.

S-6. Recommendations and Next Steps

The conclusion of the Urban Transit ITS Deployment Plan is that ITS applications can be beneficial to the state's transit systems and transit agency managers have a high level of interest in these technology tools.

It is recommended that the urban transit agencies, working with Iowa DOT OPT and in the context of the Steering Committee pursue implementation of the recommendations included in the Deployment Plan report. It is recommended that urban transit agencies deciding to move forward begin the preparation of an Agency Technology Plan. This is a more detailed plan for technology deployment tailored to each individual agency.

Beyond the Deployment Plan, the following four steps should be taken before ITS systems are procured and implemented:

1. **Develop Funding Plan**

   The funding plan should identify sources of funding for the associated capital and ongoing operating and maintenance costs of technology deployment.

2. **Development of Specifications:**

   a. **Prepare Functional Requirements.** A functional requirement indicates what capability the system is required to achieve.

   b. **Prepare Functional Specifications.** The functional requirements should translate into a set of structured specifications.

3. **Procurement of ITS Technologies: This will include the following steps:**

   - **Develop and Issue a Request for Proposals** (RFP) that includes the functional pecifications.
   - **Develop Evaluation Plan** to guide the proposal evaluation process.
   - **Conduct a Pre-Proposal Meeting**
   - **Receive and Evaluate Proposals**
   - **Interview Short-listed Proposers** (if desired) and evaluate interviews.
   - **Issue a Request for Best and Final Offers** (BAFO)
   - **Make Final Vendor Selection**
   - **Negotiate and Award Contract**

4. **Implementation of Procured ITS Technologies:** This phase follows the procurement and results in the full deployment of the technologies.

1. Introduction

This report summarizes the findings and conclusions of the Statewide Large Urban Transit Systems Intelligent Transportation Systems (ITS) Deployment Plan study. In early 2006, the Iowa Department of Transportation engaged the TranSystems Team to assist in the development of a statewide ITS deployment plan for Iowa's large urban transit systems. The purpose of the Plan is to provide a means for transit agencies in large urban communities to utilize ITS applications to support and enhance transit operations. The project is a study of the needs and opportunities related to the expanded deployment of ITS applications by the transit agencies. Transit systems large and small around the country have realized benefits through the deployment of technology systems. Benefits include enhanced reliability, greater efficiency, improved safety and security and improved customer service. Moreover, improving operations efficiencies through the use of ITS results in reduced fuel usage by transit systems, in turn reducing pollution. Making transit systems more appealing to the public by improving service and efficiencies through ITS, also helps luring more drivers to switch to transit. Rural transit agencies in Iowa have implemented ITS technology in recent years with favorable results. With few exceptions, the state's urban transit systems do not have available current technology systems. The Steering Committee consists of the individuals shown below in Table 1.

Table 1. Members of the Steering Committee

Name	Agency
Bob Krause	Iowa DOT- Office of Public Transit
Peter Hallock	Iowa DOT- Office of Public Transit
Matthew Simaytis	City of Bettendorf
Mark Little	Black Hawk County
Vicky Robrock	Coralville Transit
Sheri Kyras	CyRide
Pete Donner	Davenport CitiBus
Brad Miller	Des Moines Area Regional Transit Authority
Jon Rodocker	City of Dubuque- Keyline Transit
Bill Hoekstra	Five Seasons Transportation & Parking
Ron Logsden	Iowa City Transit
Curt Miller	Sioux City Transit
Brian McClatchey	University of Iowa

The project was lead by a Steering Committee comprised of representatives from participating urban transit agencies and the Iowa Department of Transportation Office of Public Transit. The Steering Committee provided input to the consultant on needs within the transit agencies and reviewed conclusions and recommendations throughout the course of the project.

1.1 Organization of the Report

This report is organized into nine sections in addition to this introduction, as follows:

- Section 2 provides background information on the large urban transit systems in Iowa.
- Section 3 describes the methodology and steps followed in conducting this deployment plan.
- Section 4 briefly describes some of the challenges experienced by the diverse urban transit systems.
- Section 5 provides a summary of the existing communications systems, as well as future communications requirements for each of the agencies included in this study.
- Section 6 describes the recommended ITS technologies and their costs for each transit agency. The section also describes the recommendations for deployment phasing.
- Section 7 provides a summary of expected organizational and technical impacts as a result of the recommended ITS deployments.
- Section 8 provides recommendations on procurement strategies.
- Section 9 provides information on National ITS Architecture. It describes the user services, market packages and equipment packages associated with each of the recommended transit ITS technologies.
- Section 10 describes the next steps required to deploy the recommended technologies.

1.2 Plan Purpose and Use

The purpose of this ITS Deployment Plan is to identify technologies that are recommended for implementation; describe their characteristics, costs and benefits; identify resources and training requirements; and define preliminary implementation timeframes. The Deployment Plan contains information that can be used to:

- Determine whether technology is needed, and if so, what kinds of technologies;
- Determine and/or validate the appropriate "phasing" of various technologies;
- Facilitate management understanding on technology;
- Understand the use of technology in the transit system;
- Plan the specifications development processes;
- Initially determine resource requirements (e.g., operations, maintenance, administration);
- Determine the impact on the organization(s) and employees, and plan to manage these impacts;
- Assist Iowa DOT and agencies in securing ITS funding through grants and earmarks;
- Plan for initial and full deployment of multiple technologies; and
- Plan for project evaluations.

1.3 Plan Assumptions

This Plan covers the period from 2007 to 2012. A phasing plan is shown for each transit agency in Section 6. The assumptions that were used to develop this schedule and the Plan include the following:

- The schedule reflects the most realistic timing for the procurement and subsequent implementation of each technology.
- The procurement method used to purchase each technology or group of technologies will be based on Federal Transit Administration (FTA) and/or Iowa Department of Transportation (DOT) guidelines for each project. We recommend the use of a competitive request for proposals (RFP) method for most of the technologies described in this Plan. Using any other method such as a low-bid competitive procurement (e.g., two-step bid), may require a change to the individual and overall schedules for implementation.
- The recommended technologies and systems will be consistent with the applicable Local Area ITS Architecture and will be compliant with the FTA policy.
- Several recommended technologies cannot be implemented without others being procured and implemented first, including:
    - Communications systems will need to be upgraded for some of the agencies included in this project in order for certain ITS technologies to function;
    - A real-time traveler information system can only be implemented after an automatic vehicle location (AVL) system is fully operational; and
    - An automated annunciation/signage system should be implemented as part of an AVL system.

2. Transit in Iowa

This section provides an overview of the large urban transit systems. In Iowa large urban transit systems are defined as systems that operate in a metropolitan area with a population of 50,000 or more. This includes information on the fleet size, ridership and service characteristics.

Twelve (12) large urban transit systems provide transit services throughout the state of Iowa as shown in Table 2. However, only ten fully participated in this project. The City of Bettendorf participated initially, however the City is currently in the process of implementing transit ITS technologies as part of a broader ITS program within the City. Council Bluffs did not participate because Omaha Metropolitan Area Transit provides service in Council Bluffs. Omaha MAT deployed an ITS system several years ago. Figure 1 shows the transit agencies throughout the state.

Table 2. Large Urban Transit Systems

City	Agency
Sioux City	Sioux City Transit
Waterloo	Metropolitan Transit Authority of Black Hawk County
Dubuque	Keyline Transit
Bettendorf	Bettendorf Transit
Davenport	CitiBus
Cedar Rapids	Five Seasons Transportation
Coralville	Coralville Transit
Iowa City	Iowa City Transit
Iowa City	University of Iowa, Cambus
Ames	CyRide
Des Moines	Des Moines Area Regional Transit Authority
Council Bluffs	Omaha Metro Area Transit

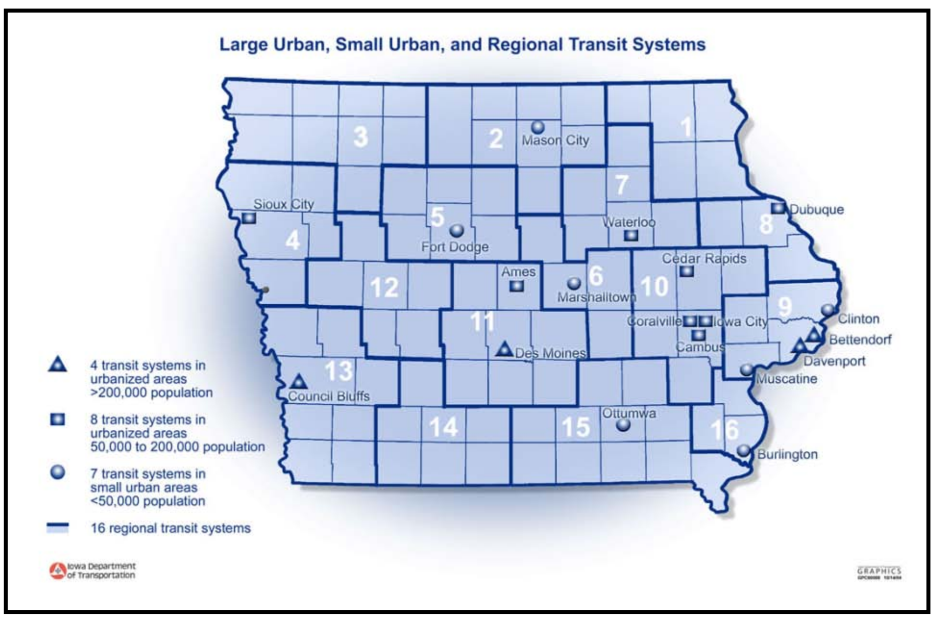

Figure 1. State of Iowa Public Transit Systems

2.1 Cambus, The University of Iowa

Cambus is a division of the University's Parking & Transportation Department. Cambus operates 23 peak period fixed route vehicles providing intra-campus circulation and connects several large remote park & ride lots with locations on campus. Paratransit service, referred to as the Bionic Bus, is provided with three vehicles and services the metropolitan area.

There is a high degree of coordination among Cambus and the other two transit operators in the Iowa City area, Iowa City Transit and Coralville Transit. All three systems share a downtown transit interchange on Washington Street at Clinton. The systems also interface in the Medical Center on West Campus.

Daily ridership on the fixed route system is approximately 20,000 per day when classes are in session. Ridership drops to about 6,000 per day when classes are not in session. Cambus is unique because it is a student run operation. Cambus has approximately 160 student employees, all part-time. This includes 130 drivers, dispatchers, supervisors and maintenance personnel. Brian McClatchey, transit manager, noted that ITS applications for Cambus would have to be designed with considerations of the student work force. Although the student employees are more likely to be familiar with technology, turnover is obviously high and they are all part time with limited time to develop procedures for the use of technology.

Funding for the system is derived from the following sources: 40% from student fees, 30% from parking fees, 20% from state assistance funds, and 10% from Federal 5307 funds. Student fees are approximately $18.00 per semester and are administratively levied by the University.

Population: Students 29,000, metro area: 115,000

Annual ridership: 3.6 million

Types of services provided: Fixed route and paratransit for persons with disabilities.

Routes: 13 fixed routes

Fleet size: 32

Employees: 5 (full time), 160 (part time)

Administrative: 23 (1 full-time)

Maintenance: 6 (4 full-time)

Drivers: 130 all part time

Operating facilities: On campus facilities

2.2 CitiBus, Davenport

CitiBus is a unit of Davenport city government under the Public Works Department. CitiBus operates within the City of Davenport, but crosses the Mississippi River to connect with MetroLINK in Rock Island, Illinois and connects with Bettendorf Transit at the city line. CitiBus has 12 routes and some routes employ minor route deviation. Most of the routes operate in a pulse configuration from a downtown transit center. Service frequency is 30, 40, and 60 minutes depending on route. However, the 40-minute service may be eliminated in the fall of 2006. Paratransit service is contracted to River Bend Transit.

CitiBus has a fixed-route fleet of 20 vehicles (17 peak vehicles). Currently, 46 drivers are required to operate the service (28 full-time and 18 part-time).

First Transit provides a General Manager and five other management/administrative staff for the transit system. The drivers, however, are City employees. Vehicles are housed and maintained in Rock Island in the joint-transit facility governed by the Quad City Garage Policy Group Board of Directors. Davenport does expect to construct its own transit operations and maintenance facility within 3 to 5 years.

Population: City: 98,000, metro area: 358,000

Annual ridership: 965,000

Types of services provided: Fixed route

Routes: 12 fixed routes

Fleet size: 20 fixed route vehicles

Employees: 31 (full time), 14 (part time)

Administrative: 7

Drivers: 46, 28 fulltime and 18 part time

Operating facilities: Joint operating facility in Rock Island, Illinois.

2.3 City of Bettendorf

The City of Bettendorf operates a small fixed route system within the city limits, with connections to Davenport's CitiBus and across the Mississippi River to MetroLINK in Moline. The system has five routes operating as a pulse system with a fleet of 11 vehicles. The City and other nearby jurisdictions considered consolidation of the transit system in the past, but this idea has been dropped. The City and the nearby jurisdictions are actively engaged in efforts to coordinate services.

River Bend Transit (RBT) contracts to provide their paratransit service. RBT also provides Saturday service in Bettendorf.

Population: City: 31,000, metro area: 358,000

Annual ridership: (not stated)

Types of services provided: Fixed route

Routes: Five fixed routes

Fleet size: 11 fixed route vehicles

Employees: 2 (full time), 11 (part time)

Administrative:

Drivers:

Operating facilities: Shared use of city facilities.

2.4 Coralville Transit System, Coralville

Coralville is a rapidly growing city of 17,000, adjacent to Iowa City Coralville transit is a unit of city government. The transit system is relatively small with three fixed routes operating with six peak period buses (fleet size is 11 vehicles). Paratransit is contracted to Johnson County Seats.

Daily ridership is approximately 1,800 and has been growing with a high percentage of choice riders. The high ridership is attributed to being a university community.

Consolidation with the Cambus and Iowa City Transit has been studied in the past but has not been acted upon. The three transit systems do work closely together and service is coordinated. There is a reciprocal transfer agreement between Coralville and Iowa City (Cambus is fare free). The services do not overlap but there is a common transfer point in downtown Iowa City on Washington Street.

Population: City: 17,000, metro area: 115,000

Annual ridership: (not stated)

Types of services provided: Fixed route

Routes: Three fixed routes

Fleet size: 11 fixed route vehicles

Employees: 11 (full time),11 (part time)

  Administrative: 1

  Drivers:

Operating facilities: City transit facility

2.5 Council Bluffs

Council Bluffs is regarded as one of Iowa's large urban areas; however it is part of the Omaha, Nebraska metropolitan area. Fixed route transit service is provided under contract by Omaha Metropolitan Area Transit (MAT). Paratransit service is provided under contract by an Omaha ambulance company. Omaha MAT has an existing Transit ITS system with AVL/CAD and other features. Council Bluffs chose not to participate in the project

Population: City: 58,000, metro area: 741,000

Annual ridership: 19,200 (1,600/month)

Types of services provided: Fixed route

Routes: 5 provided by MAT

Fleet size: 5 fixed route vehicles

Employees: 1 (part time)

  Administrative: N/A

  Drivers: N/A

Operating facilities: Omaha MAT transit facility.

2.6 CyRide, Ames

CyRide is governed by an independent board but is administered as a department of the City of Ames. About 95% of the service is oriented to the Iowa State University campus. Typical ridership when school is in session is between 22,000 to 25,000 daily trips. When school is not in session, however, ridership drops to about 3,000 trips per day.

CyRide operates four campus oriented routes with very high ridership, one with peak headways in the range of three to five minutes. The other routes have headways of ten minutes. CyRide also provides an airport shuttle for students during Thanksgiving, winter, and spring breaks. CyRide’s fleet consists of 63 vehicles. Paratransit service is contracted out to Heartland Senior Services.

Population: 25,000 (students), City: 51,000, metro area: 80,000

Annual ridership: 4,173,208

Types of services provided: Fixed route

Routes: 10 fixed routes

Fleet size: 63 vehicles

Employees: 124 employees

- Administrative: 9
- Maintenance: 13
- Drivers: 90

Operating facilities: On campus facilities

2.7 Des Moines Area Regional Transit Authority (DART), Des Moines

DART is a regional transit authority governed by an independent board. DART's bus routes cover the cities of Des Moines, Clive, Urbandale, West Des Moines, Windsor Heights and Johnston. In addition, DART 's commuter routes serve Altoona and Ankeny. The DART has 9 regular fixed routes, 7 express routes, 2 commuter routes, 2 downtown shuttles and 5 On-Call zones. DART’s fixed route fleet is 118 vehicles (90 peak fleet). About 4.2 million unlinked trips are provided annually.

DART paratransit provides demand response transportation service to senior citizens and persons with disabilities. Riders must make reservations by calling at least one working day before the trip is to be taken.

In addition to bus service, DART offers other alternatives to driving alone. DART's Vanpool Program has a fleet of full-size passenger vans and minivans that are used by groups of commuters for trips to and from work. More than 70 vanpools are now on the road.

Population: City: 200,000, metro area: 500,000

Annual ridership: 4.2 million

Types of services provided: Fixed route, paratransit and vanpools

Routes: 9 fixed routes, 9 express routes, 1 shuttle route (downtown), 5 on call routes

Fleet size: 143 buses; 68 vanpool vehicles

Employees: 219

Administrative: 42

Maintenance: 35

Drivers: 142

Operating facilities: DART owned storage and maintenance facility.

2.8 Five Seasons Transportation, Cedar Rapids

Five Seasons Transportation (FST) is operated under the Director of Transportation & Parking for the city of Cedar Rapids. Policy direction is provided by the mayor and city council.

FST provides fixed route and demand-response service for the cities of: Cedar Rapids, Marion and Hiawatha. FST operates 14 routes with service hours from 5:30 a.m. to 7:15 p.m. on weekdays and from 7:55 a.m. to 5:30 p.m. on Saturdays. Evening service is provided by Neighborhood Transportation Service, Inc. (NTS). FST provides about 1.3 million trips a year.

Since late 1983 FST has utilized the Ground Transportation Center located in downtown Cedar Rapids as its transfer point, and for dispatching. The facility is a joint venture, also housing intercity carriers and a Montessori School on the main level and private development on upper floors.

Population: City: 122,000, metro area: 196,000

Annual ridership: 1.3 million

Types of services provided: Fixed route, paratransit

Routes: 14 fixed routes

Fleet size: 61 vehicles

Employees: 63 (full time), 9 (part time)

Administrative: 16

Maintenance: 9

Drivers: 47, 40 full time, 7 part time

Operating facilities: FST owned storage and maintenance facility.

2.9 Iowa City Transit, Iowa City

Iowa City Transit (ICT) is a unit of Iowa City government. ICT is one of three transit providers in the Iowa City area. The three systems work closely together and provide well coordinated service, as previously explained. ICT provides fixed-route service throughout the Iowa City area. A total of 25 vehicles are operated on 19 routes (with a peak fleet of 20 vehicles). ICT operates every half-hour on most routes during "rush" hour, 6 a.m. to 9 a.m. and 3 p.m. to 6:30 p.m., Monday through Friday. Hourly service runs 9 a.m. to 3 p.m. and 6:30 p.m. to 10:30 p.m., and all day Saturday from 6 a.m. to 7 p.m. There is no service on Sunday.

Paratransit service is contracted to Johnson County Seats.

Population: City: 63,000, metro area: 115,000

Annual ridership: 1,708,000

Types of services provided: Fixed route, paratransit

Routes: 17 fixed routes, 2 express routes, 2 shuttles

Fleet size: 25 fixed route vehicles, 10 paratransit vehicles

Employees: 58

Administrative: 6

Maintenance: 7

Drivers: 40

Operating facilities: ICT owned storage and maintenance facility

2.10 Keyline Transit, Dubuque

Keyline is administered by the transit manager who reports to the city administrator. Policy direction is provided by the city council acting on the advice of the Dubuque Transit Trustee Board. Keyline Transit operates both fixed route and paratransit service within the city of Dubuque. Keyline has a peak fleet of eight fixed route buses and eleven paratransit vehicles.

Population: City: 58,000, metro area: 91,000

Annual ridership: 198,000

Types of services provided: Fixed route, paratransit

Routes: Eight fixed routes

Fleet size: 25 vehicles

Employees: 43, 15 (full time), 18 (part time)

Administrative: 8

Drivers: 35

Operating facilities: City public works facility

2.11 Metropolitan Transit Authority of Black Hawk County, Waterloo

MET is an independent transit authority serving the cities of Waterloo and Cedar Falls, governed by an independent board. Met provides both fixed route and paratransit service in the metropolitan area. The fixed route system has 11 peak buses (and 4 spare vehicles) and 10 routes operating as a pulse system.

Transfers are made at Park Avenue and Sycamore Street at a transfer center. The transfer facility is shared with Trailways intercity bus. Ridership on the fixed route system is 430,000 per year. The paratransit service operates with 14 peak period buses and serves between 250 and 300 daily trips

Population: City: 67,000, metro area: 126,000

Annual ridership: 430,000

Types of services provided: Fixed route, paratransit

Routes: Ten fixed routes

Fleet size: 32 vehicles

Employees: 51

Administrative: 4

Maintenance: 7

Drivers: 40

Operating facilities: MET owned storage and maintenance facility.

2.12 Sioux City Transit, Sioux City:

Sioux City Transit is a Department of the City. Sioux City Transit operates fixed route service in Sioux City and limited service in South Sioux City and North Sioux City under an agreement with these other cities. The City has a population of about 84,000 with about 140,000 in the metropolitan area.

Population: City: 84,000, metro area: 124,000

Annual ridership: 815,658

Types of services provided: Fixed route, paratransit

Routes: 14 fixed routes

Fleet size: 25 vehicles

Employees: 25 (full time), 11 (part time)

Administrative: 4

Drivers: 26

Operating facilities: City facility

3. Study Methodology

This Report is the result of several tasks, meetings and findings from previous deliverables, including *Potential ITS Applications for Iowa Urban Transit Systems*, *Existing Communications Analysis*, the *Needs Assessment* and briefing papers on Transit ITS Funding Considerations, Transit Technology Applications for Campus Bus Services and Small Fixed Route System Technology Applications. The project includes the following seven tasks:

- Task 1. Needs Analysis
- Task 2. Inventory and Needs Assessment Documentation
- Task 3. Assessment of Available Technologies
- Task 4. Available Technologies Documentation
- Task 5. Prioritization of ITS Improvements
- Task 6. Urban Transit ITS Deployment Plan
- Task 7. Final ITS Deployment Plan Report

In Tasks 1 and 2, the TranSystems Team conducted a needs assessment through staff interviews and a review of various aspects of transit agencies operations. This ITS Deployment Plan is based on an assessment of the needs and business practices of each of the eleven agencies that took part in this project. Site visits were conducted at each agency, which consisted of interviews with key agency staff, observations of work processes and review of written materials including external and internal reports. The results of these site visits were evaluated and compiled in a document entitled "Needs Assessment."

The purpose of the Needs Assessment was to identify the management systems and business practices in use at each of these transit systems. The overall goal of the assessment was to determine whether ITS applications could be used to address specific needs. Another purpose was to determine the status and type of technology already used by these agencies. To facilitate the on-site interviews, the consultant team developed a questionnaire that was distributed to the transit agencies prior to the site visit. The surveys covered these basic topics:

- Overview of system operations;
- Overview of communications systems;
- 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; and
- Perceived and actual agency barriers/opportunities for implementing advanced technology.

Tasks 3 and 4 consisted of providing detailed information about various transit ITS technologies that are currently available for deployment. In addition to describing each technology, information on the technologies benefits, delivery mechanisms, modalities, and applicable User Services and Market Packages from the National ITS Architecture were described. Further, TranSystems provided two additional documents regarding the applications of ITS technologies: one included examples of ITS technologies deployed at college campus transit systems, while the second included examples of deployments at small fixed-route systems.

On July 7, 2006, a consensus building meeting took place at Iowa DOT. In that meeting, each member of the Steering Committee determined the priority of their own agency's needs. Further, the Committee assigned the timeframe in which each need should be addressed (short-term, medium-term, or long-term). Steering Committee members who were not present at the consensus meeting completed their prioritization exercise at a later date.

Based on the findings from the previous tasks and the outcome of the consensus building meeting, the TranSystems Team prepared this draft ITS Deployment Plan as part of Tasks 6 and 7.

4. Challenges

One of the challenges of this project was the diverse nature of the transit agencies included in this study. The differences among these agencies are as follows:

- **Fleet Size:** Agencies included in this study cover a wide range of fleet sizes. For example, Bettendorf runs a fleet of seven vehicles, while DART's fleet includes almost 120 vehicles. Different sizes of operations have different needs and issues. This in turn, makes finding common ground among these agencies challenging.

- **Level of ITS Deployments:** After conducting the staff interviews, as part of the Needs Assessment phase, it became apparent that some agencies have considerable experience with ITS technologies while others have none. For example, DART has deployed numerous technologies including a computer-aided dispatch (CAD)/automatic vehicle location (AVL) system, scheduling software, on-board cameras, an electronic payment system (EPS) and real-time information. On the other hand, two agencies have not deployed any technologies while the rest of the agencies have deployed anywhere between one and four technologies. The challenge was to make sure that all project participants had the same level of understanding of ITS technologies, their benefits and implications. To overcome the different level of exposure to ITS, the TranSystems Team provided material on transit ITS technologies and conducted a workshop that covered each of the currently available transit ITS technologies.

- **Clustering of Agencies:** Large urban systems can be divided into two categories based on their proximity to each other. Systems that are geographically close may help in reducing the cost of deploying ITS technologies since some of these technologies may be shared. Bettendorf and Davenport are very close to each other, as are Iowa City, Coralville, and Cambus. Thus, for example, instead of procuring three distinct CAD/AVL systems for Iowa City, Coralville and Cambus, the three agencies could purchase one system and share its resources. (Some agencies such as Sioux City, Waterloo and Dubuque are not close to any other agency.)

5. Communications

5.1 Introduction

5.1.1 Overview

ITS technologies rely on communications to deliver all data between vehicles and dispatching centers. Without sound, reliable communication system, ITS technologies would not function properly. Hence, it of a great importance that communications systems be evaluated at the outset of any ITS deployment projects to ensure that a good communications system is in place that will provide the required, frequencies, coverage, and capacity. This section, discusses both the existing communications systems at the urban agencies as well as their future needs.

RCC, in conjunction with TranSystems, has been tasked with the assessment of wireless mobile data communications system technologies that may be considered for the future deployment of ITS technologies by the Iowa Large Urban Transit System Agencies. The technology assessment consists of various communications system offerings by commercial carriers as well as private radio technologies that may be considered for implementation by each agency. The communications system technologies are assessed as to their suitability to meet the agencies communications needs and requirements.

5.1.2 General

The purpose of this report is to identify and analyze the various communications technologies available to the large urban transit agencies operating within the State of Iowa. The primary consideration of the analysis is to determine the suitability of the various communications system technologies to support current and future ITS technology deployments for the following agencies:

- Ames CyRide
- Bettendorf Transit
- University of Iowa Cambus
- Iowa City Transit
- Cedar Rapids Five Seasons Transportation
- Coralville Transit
- Davenport CitiBus
- Des Moines Area Regional Transit Authority
- Keyline Transit
- Sioux City Transit
- Metropolitan Transit Authority of Black Hawk County

ITS applications and devices require a data communications backbone to achieve connectivity with computer-aided dispatch and automatic vehicle location (CAD/AVL) systems. Accordingly, a wireless data communications infrastructure will be required to support ITS applications throughout the agency's service areas. Fixed route service areas are specific in nature but a quantity of paratransit, demand-response, vehicles usually requires extended area voice and mobile data communications coverage.

5.2 Communication System Technologies

5.2.1 Overview

Wireless communications systems are required to support voice and/or mobile data communications throughout an agency's service area. Each agency's communications needs and system requirements are unique to the agency's overall size and number of vehicles, area of operation, and geography. In the past, a simple voice radio communications system was usually sufficient to support most agencies but the evolution of ITS technologies and on-board mobile data terminals and systems have added a need for digital mobile data communications.

Agencies are faced with the selection of various ITS components, each of which have their mobile data bandwidth requirements. For example, a mobile data infrastructure designed to support CAD/AVL would fall far short of supporting bandwidth intensive applications such as video.

At the most basic level, the design and implementation of a communications system must consider the type and amount of information to be carried, the number of vehicles to be supported, and the geographic area that requires wireless coverage. The selected communications system technology must support all of the agency's operational requirements and be affordable. Careful consideration should be given to the initial implementation costs as well as the ongoing recurring cost of operation and maintenance. For example, a large agency with hundreds of vehicles may benefit from the implementation of a private system that has a higher initial cost but a much lower operating cost per unit than a commercial system. An agency with only a few vehicles may find the low initial cost of a commercial system attractive and the higher recurring costs per unit to be manageable due to the fewer number of vehicles.

5.2.2 Application and Infrastructure Relationship

The ability to implement various applications is dependent on the bandwidth that is available. The following tables provide an overview as to the bandwidth requirements associated with these applications. The total system bandwidth requirements will be dependent on the number of users, number of messages, and size of messages. As the number of users and the number of messages increase, additional capacity must be added at the same (or greater) bandwidth to accommodate the additional bandwidth requirements. Typical system bandwidth and application bandwidth requirements are shown in the tables below:

Table 3. Typical Data Rates

Mobile Data Technology	Data Rate
Conventional Radio	4.8 – 64 Kbps
Commercial Cellular – Verizon Wireless	60 – 80 Kbps
Trunked RACOM EDACS	9.6 Kbps
Wireless LAN	512 Kbps – 1.5 Mbps

Kbps: Kilobytes per second
Mbps: Megabytes per second

Table 4. Typical Bandwidth Requirements

<table>
<tr><th>Application</th><th>Bandwidth Requirement</th></tr>
<tr><td>CAD, status messages</td><td rowspan="4">4.8 – 9.6 Kbps</td></tr>
<tr><td>AVL (limited refresh)</td></tr>
<tr><td>Real-time Dynamic Message Signs (DMS)</td></tr>
<tr><td>Maintenance Management Alarms</td></tr>
<tr><td>Pictures (low resolution)</td><td rowspan="2">19.2 – 64 Kbps</td></tr>
<tr><td>Intranet</td></tr>
<tr><td>Pictures (high resolution)</td><td rowspan="2">100 – 300 Kbps</td></tr>
<tr><td>Video Streaming (slow video, compressed)</td></tr>
<tr><td>Video (real-time, MPEG-4 compression)</td><td rowspan="3">> 1.5 Mbps</td></tr>
<tr><td>Software updates</td></tr>
<tr><td>Traffic cameras</td></tr>
</table>

Kbps: Kilobytes per second
Mbps: Megabytes per second

Note: Video requirements vary significantly with the size of the image, color or black & white, refresh rate, resolution, compression techniques and other factors.

5.2.3 Private Communications Systems

Private communications systems are purchased for the exclusive use of the procuring agency and are usually wide-area in design. A private system may be implemented to support a transit agency only or may be implemented by a city or state and local entity to support many user groups. The agency procures tower sites, equipment, and the infrastructure for the entire communications network. Private systems allow the agency total control over the network.

There are however, initial costs for the procurement of equipment, engineering, installation of towers and equipment, and connectivity in the form of microwave or Telco leased lines. To reduce implementation costs, private system owners often share communications systems and site resources such as tower sites, equipment shelters and, possibly, antenna systems.

The successful implementation of a private wireless communications system requires proper engineering and planning. In addition to selecting the system technology and equipment manufacturer, there are many technical and operational choices to be considered as well. In most cases, separate radio channels are utilized for voice and data communications.

5.2.3.1 Radio Frequencies

In order to determine if a licensed private conventional wireless infrastructure is viable, frequency searches must be performed in the selected frequency bands to determine the availability of frequencies in the service area.

5.2.3.2 Coverage Analysis from Proposed Radio Sites

Private systems usually consist of one or more base station sites located at a high elevation so that radio coverage is achieved over a large geographical area. Radio coverage must be modeled by special software applications for the proposed tower sites to ensure reliable coverage across the entire service area.

The preliminary coverage maps would indicate the number of tower sites that would be required to provide radio coverage in the selected service area. Leased lines or wireless connectivity circuits for backhaul to the transmitter/receiver sites will be required to connect the wireless infrastructure to the agency's main facility.

5.2.3.3 Conventional Private Voice Communications System

Conventional voice communication systems are usually analog as opposed to digital in nature due to the typically higher costs associated with digital infrastructure and subscriber radio equipment. For transit communications, conventional voice systems are usually constructed in the VHF and UHF frequency bands. The VHF and UHF bands are extremely common and there are a large number of equipment manufacturers and equipment models of various price points to choose. VHF and UHF systems may be implemented in a simplex or duplex configuration. The duplex configuration utilizes a repeater to greatly extend mobile and portable communication coverage.

Dispatch console equipment may be directly connected to the base station or repeater by wirelines or short range microwave radio systems. Dispatch communications may be supported by an RF control station radio that provides wireless transmission through a repeater in the same manner as a mobile or portable radio user.

Conventional voice communication systems may be easily expanded, subject to frequency availability, as agency needs may require. Additional base stations or repeaters may be added to increase system capacity or to extend the area of radio coverage.

5.2.3.4 Conventional Private Mobile Data Communications System

Conventional private wireless systems have been serving transit agencies for many years and have proven to be very effective in meeting the mobile data communications needs of ITS implementations.

Private Radio General Mobile Data refers to those privately owned systems that are designed to provide higher performance for general mobile data applications including text messaging and larger file transfer. Data rates typically range from 4.8 Kbps to 64 Kbps. Data rates of 4.8 Kbps to 9.6 Kbps are common with the most basic analog modulation systems. Data rates from 19.2 Kbps to 64 Kbps are usually proprietary systems from vendors including DataRadio, IPMobilenet, and Motorola that utilize some form of digital modulation. The proprietary system equipment is unique to each vendor and is not interoperable between vendors. There is a trade off between data rates and radio coverage. The lower data rates provide a higher level of reliability and coverage.

The conventional mobile data system typically consists of one or more base stations and a network controller as illustrated in Figure 2.

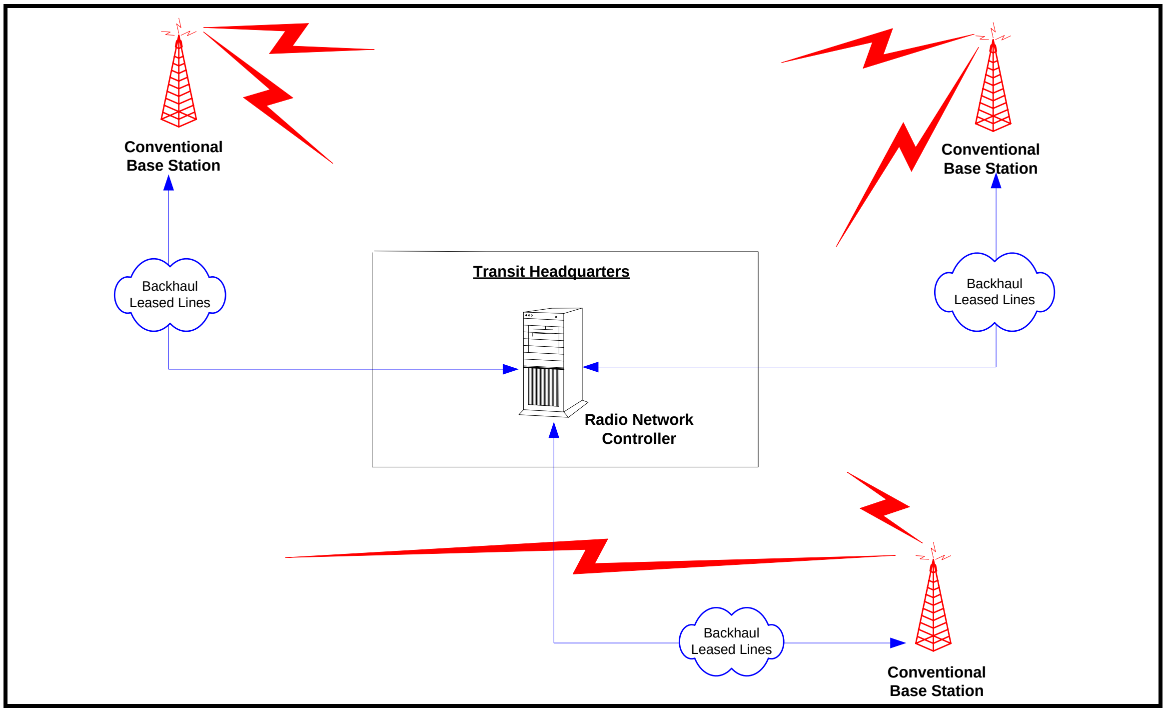

Figure 2. Conventional Mobile Data Systems

5.2.3.5 Cost Analysis

Estimated equipment and system implementation costs may be calculated based on the amount of infrastructure equipment and sites that are required to cover the agency's service area. This would include procurement of communication tower antenna sites, and connectivity to the dispatch or operation center. Conventional systems require the purchase of base station infrastructure that is typically less expensive than more complex systems such as trunking or WLAN.

5.2.3.6 Maintenance and Other Recurring Costs

Recurring costs for infrastructure equipment maintenance and site connectivity costs such as leased land lines must be considered. Additional costs may include tower site leasing and utility costs. Due to the nature of an agency's operation, maintenance service may be required twenty four hours per day, seven days per week (24 x 7) on the infrastructure equipment. Maintenance of subscriber mobile and portable radios would also be required. Maintenance of subscriber equipment is usually contracted on an eight hours per day, five days per week basis during regular business hours (8 x 5).

5.2.3.7 Advantages and Disadvantages

Private radio communication systems typically utilize a few transmitter sites to cover a large geographic area. This results in a cost effective solution for large coverage areas. The capacity of the system is increased by adding additional RF channels to one or many sites enabling expansion for future growth. Since the system is private, system resources and management are under complete control of the agency.

Since the communications system is private and owned by the agency, the agency is responsible for all costs of operation and system management. Conventional mobile data communication systems provide lower data rates but a high reliability of radio coverage. Most ITS applications may be supported by the lower data rates.

5.2.4 Commercial Leased Wireless Data System Alternatives

Public commercial networks are considered, for the purposes of this report, to be networks that are not privately purchased by an agency for that agency's exclusive use, but rather end user service that is leased on a commercial network. Commercial networks are usually cellular in infrastructure design and will have other users on the network. The users could be corporations, public sector agencies or general consumers. Commercial networks offer the advantage of significantly reduced start up costs, with on-going maintenance and some technology upgrades provided as a part of the monthly recurring service. In order to be competitive, the network provider must maintain high system availability and high reliability. This means that they must continuously monitor the system for problems, upgrade the system as capacity approaches a predetermined limit, and react quickly if an outage is either reported or detected.

5.2.4.1 Cellular System Alternatives

The commercial cellular system design provides multiple channels for voice and data communications throughout the coverage area providing very high capacity. However, the public at large shares this capacity, usually with equal priority. Also, the same channel resources may be used for voice calls and data transmission. There are several cellular carriers that offer service in metropolitan areas and along major highways. They include Verizon, Sprint - Nextel, T-Mobile, and Cingular. According to the carrier's coverage maps, Sprint and T-Mobile do not offer significant broadband coverage in Iowa. The cellular carrier Verizon and their mobile data solution "NationalAccess" was used in this report as representative of a typical offering by a commercial carrier.

5.2.4.2 System Architecture and Capabilities

Verizon currently offers 1xRTT-based technology with an average data speed of 60 Kbps to 80 Kbps with bursts up to 144 Kbps. These speeds are achieved without the use of data compression, which may yield even higher speeds depending upon the application. The Verizon network is used for both voice and data traffic; however, Verizon does not currently dedicate any channels for data operation. This means that it is possible for voice call loading to block data in an area for a period of time if there is a peak in voice call activity higher than the capacity of the network in that area.

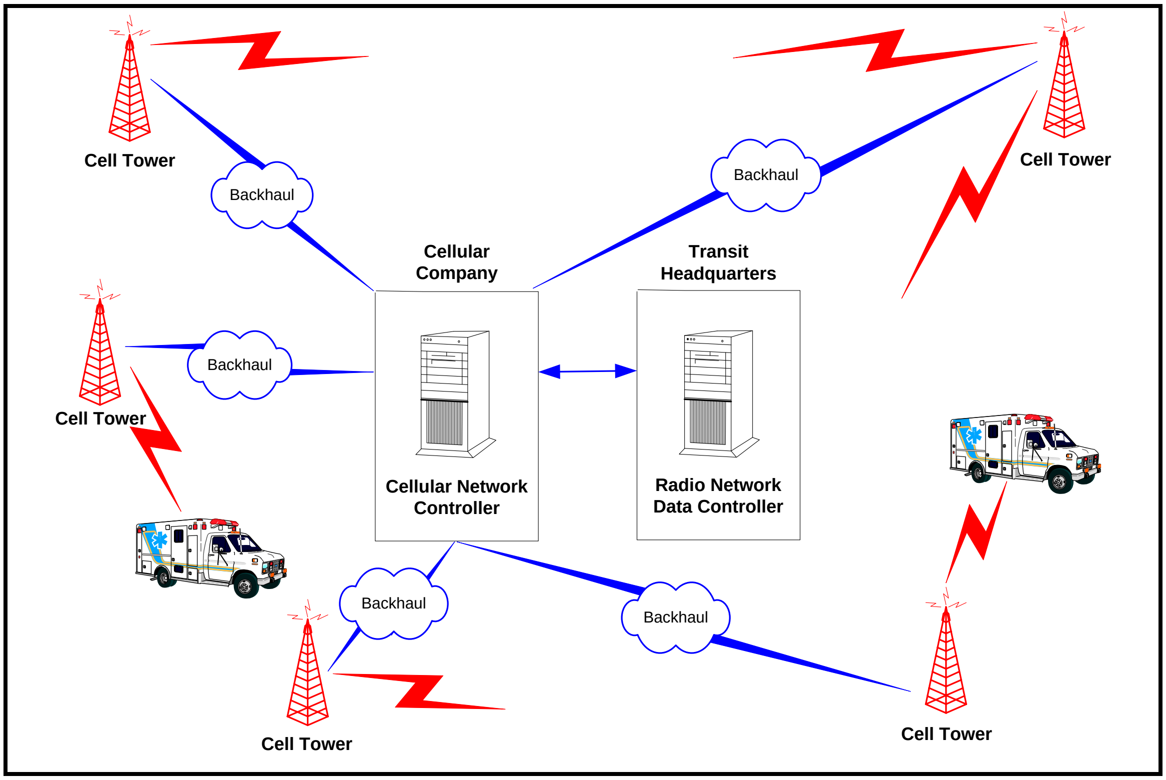

Figure 3. Cellular Mobile Data Systems

5.2.4.3 Radio Coverage Predictions

Based on coverage maps provided by Verizon, coverage appears to be adequate in metropolitan areas of Iowa and along most major highways.

5.2.4.4 Cost Analysis

The commercial carrier provides a very cost effective solution for mobile data services. No investment in infrastructure equipment and sites, system maintenance, or system management is required, so initial costs are very low. Vehicular modem costs are also lower in comparison to other technologies such as private conventional mobile data. Additionally, Verizon does not usually charge a setup or access fee for connection to their network switch.

5.2.4.5 Maintenance and Other Recurring Costs

Verizon does not charge an access fee for direct connection through frame relay or dedicated network circuits. Verizon offers public safety entities a 100 MB National Access Plan for $49.99 per month (i.e., the plan would include up to 100 MB of data transmission per month, with additional costs for data overages) or a 5 MB Plan for $24.29 per month with no activation fees. There are several wireless modems available and some include a built-in GPS receiver. It was reported that the rural agency consortium[1] has a GSA contract with Verizon Wireless and

[1] This is a collective of the regional transit systems in Iowa currently involved with implementation of transit ITS technologies.

Midwest Cellular for about $15.00 per month per unit. (Budgetary cost estimates for Verizon cellular are based on the $15.00 rate).

Annual recurring cost for mobile data subscriber access service and subscriber maintenance is estimated for the purposes of this report. This assumes an IP–VPN (i.e., internet-based) connection for the fixed end system connectivity between the transit agency and Verizon. If a frame relay connection is desired, the agency would incur the recurring circuit cost. After the initial equipment cost, a monthly fee is charged on a “per user” basis.

5.2.4.6 Advantages and Disadvantages

The primary advantage of the cellular carrier solution is the low initial and recurring costs for equipment and services. The system provides inherent redundancy due to its cellular architecture. Minimal equipment maintenance or management is required for the vehicular radio modems.
The cellular carrier solution provides data speeds in excess of a conventional UHF or 800 MHz mobile data system including the RACOM EDACS system. Additionally, mobile data services could migrate relatively easily to emerging high speed data technologies that will become increasingly available in the future to support future high bandwidth applications such as video.

The primary disadvantage is the sharing of cellular network resources with the general public, which can result in system overload during peak traffic periods and in the event of local disasters such as tornados. Technology improvements may make present technology and equipment obsolete in the future requiring equipment upgrade or complete changeout as experienced with Cellular Digital Packet Data (CDPD) service a few years ago. Another disadvantage is that the agency has little or no control of the communications infrastructure such that coverage deficiencies may not be corrected by adding base station sites as in a private conventional mobile data system.

5.2.5 Non-Cellular Leased Voice and Data System Alternatives

Another form of commercial carrier system consists of a network of “high sites” as opposed to a cellular “honeycomb” configuration. The “high site” configuration resembles a typical private public safety system where a single transmitter site is located at a high level above ground on a tower or hilltop and covers a large geographical area. Multiple transmit sites spaced several miles apart may be linked together to form a network. These systems are offered in Iowa by companies such as RACOM, Electronic Engineering Company, and Radio Communications Company.

RACOM has implemented a M/A-Com Enhanced Digital Access Communications System (EDACS) which provides voice and mobile data capabilities up to 9.6 Kbps. Other trunked system technologies from Motorola and E.F. Johnson provide only voice communications and do not provide trunked mobile data service. RACOM reported that their system consists of 90 sites and currently supports many public safety and local government agencies.

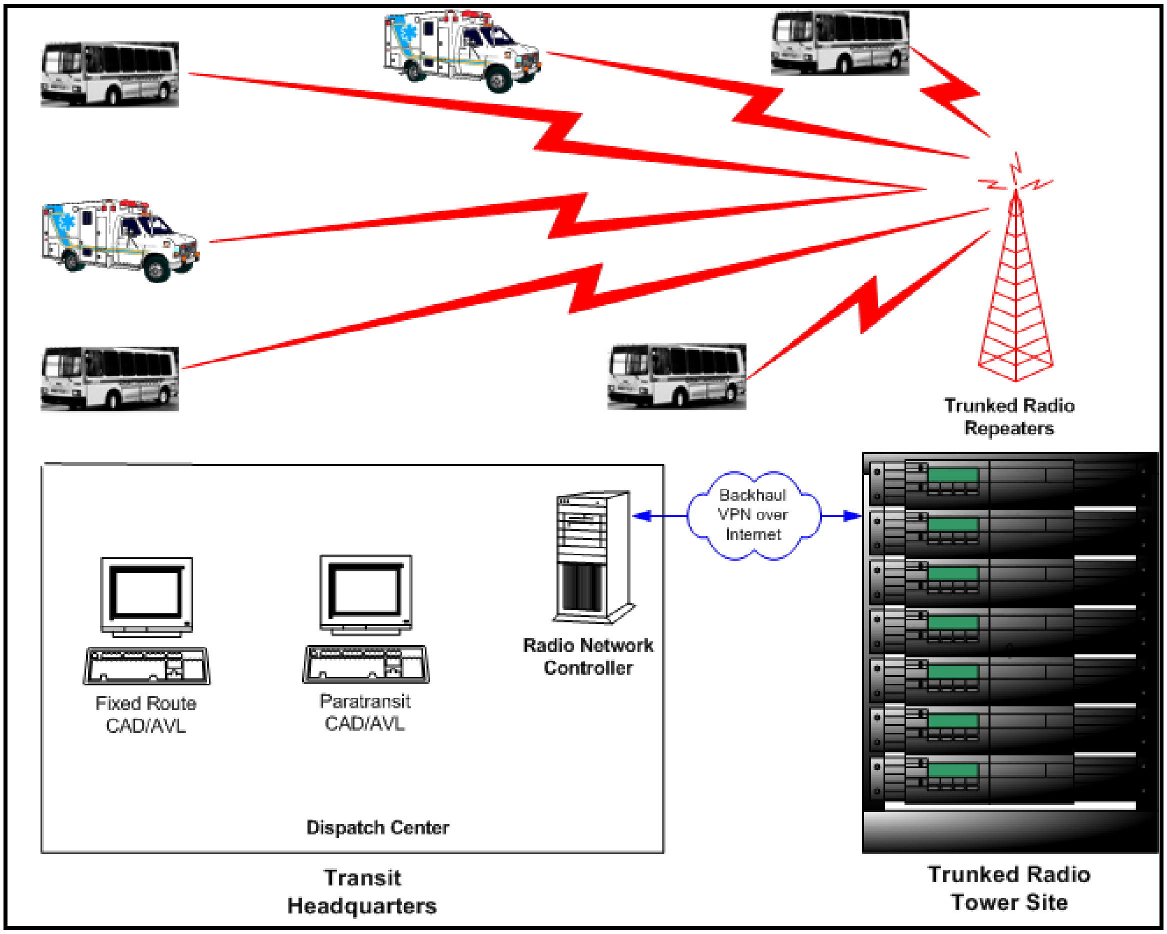

Figure 4. Trunked Radio EDACS Mobile Data Systems

5.2.5.1 System Architecture and Capabilities

Trunked radio communications systems pools radio frequencies and allows groups or agencies to dynamically share them. The time that a channel would otherwise remain idle is put to use by temporarily assigning another user group to the frequency. This dynamic sharing of frequencies results in much more efficient use of the valuable radio spectrum. The sharing is accomplished automatically, and one group would never hear the other group's radio traffic. To the user, it would seem as if his/her group had a radio frequency all to itself. Trunked radio systems allow many users and user groups to comfortably share a radio system where the number of available radio frequencies is limited.

Trunked radio is inherently redundant, which increases system reliability. For example, if a transmitter fails, the system detects the failure automatically and does not assign the failed transmitter. The remaining frequencies are assigned normally, and the users probably would not notice a difference in their operation.

Trunked radio systems offer features that are unavailable on conventional systems. Many of the agencies interviewed indicated that they are experiencing channel congestion and interference from other system users. Trunked radio systems provide multiple talk groups, which enable agencies to better segregate communications paths within and among departments. In the 700, 800, and 900 MHz frequency bands, radio channels are assigned on an exclusive basis to preclude harmful interference.

Some trunked radio systems such as EDACS, provides simultaneous voice and data transmissions over the same infrastructure. This provides additional utility of the system because data can be separated into short data bursts ("packets") and transmitted quickly during short intervals when a voice channel would otherwise be idle, such as the interval between a call and a response. The voice users are unaware that the data is being transmitted. For more intense data requirements, data communications may be provided by a dedicated mobile data RF subsystem.

5.2.5.2 Cost Analysis

Trunked radio systems are more costly to implement than conventional radio systems due to their nature and complexity. Trunked radio systems require a trunked controller and special trunked mobile and portable radio equipment. Leasing costs for trunked services are typically higher due to limited competition in the wireless market and the nature of their specialized service. Vehicular radio modems costs are typically several times that of cellular modems.

5.2.5.3 Maintenance and Other Recurring Costs

Infrastructure maintenance is provided by the system owner/operator so the agency does not incur maintenance or operational costs.

Maintenance of subscriber mobile and portable radios is required. Maintenance of subscriber equipment is usually contracted on an eight hours per day, five days per week basis during regular business hours (8 x 5).

5.2.5.4 Advantages and Disadvantages

Trunked radio systems are more costly to implement than conventional radio systems but have the ability to support a larger number of users per radio channel because of its efficiency. The capacity of the system is easily increased by adding additional RF channels to support additional users. The trunked radio system utilizes several channels so it is inherently redundant in that a failure of a repeater does not result in a total loss of communications. The cost of trunked mobile and portable equipment is higher than conventional equipment. Higher implementation and operating costs should be expected with implementation of a trunked communications solution.

The primary disadvantages of the EDACS system is the slow 9.6 Kbps data speed and the higher radio modem cost. Another disadvantage is that the agency has little or no control of the communications infrastructure such that coverage deficiencies may not be corrected by adding base station sites as in a private conventional mobile data system.

5.2.6 Wireless LAN (WLAN) Networking Technology

WLAN technology is included not as an alternative to a leased or private wide-area mobile data or AVL infrastructure, but rather as a technology that can augment its performance. This technology is currently being used by some agencies as an alternative to slower speed wireless connections for moving large data files that are not real-time critical. However, WLAN technology is not well suited to wide-area wireless communications (except possibly for public carriers) due to the very high number of transmitter sites that would be required for a large service area. Access points may be required every ¼ to ½ mile to provide seamless communications. Typically, WLAN is well suited for local area wireless communications or smaller towns.

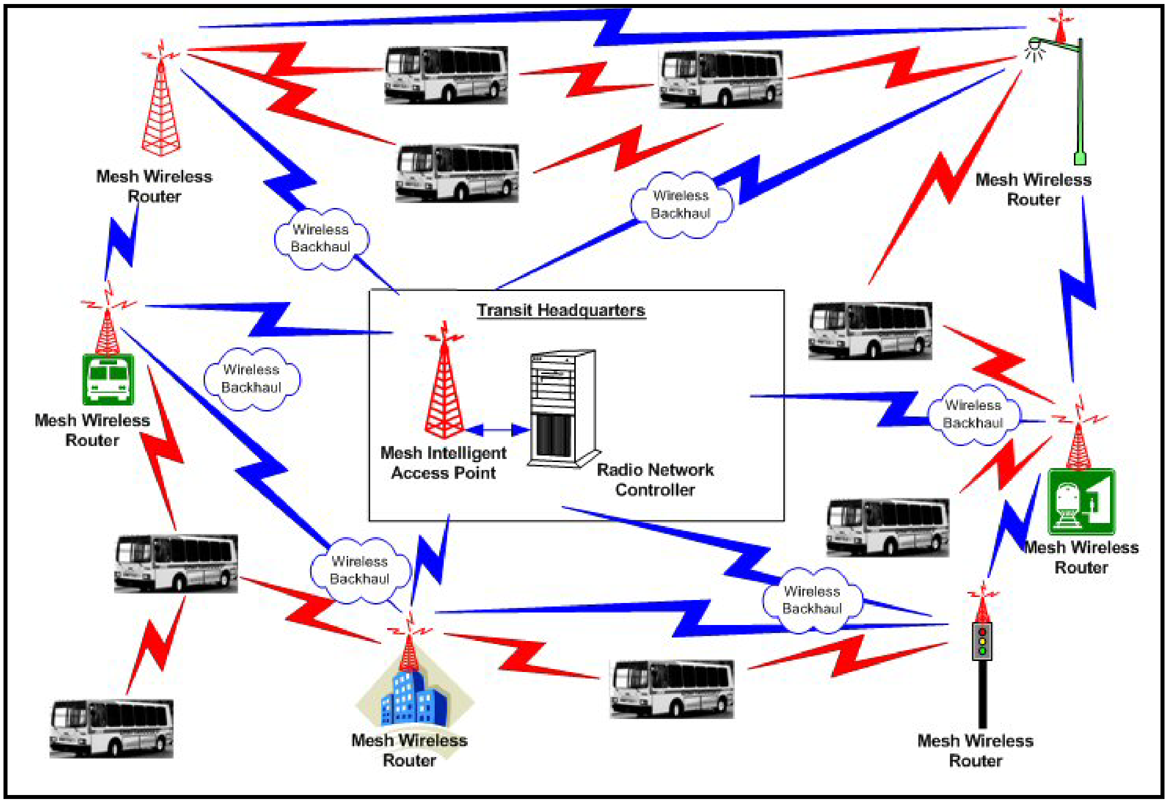

Figure 5. Mesh WLAN Mobile Data Systems

5.2.6.1 System Architecture and Capabilities

The Motorola Mesh Network technology is one example of WLAN that utilizes the unlicensed 2.4 GHz Industrial, Scientific, Medical (ISM) frequency band, as with 802.11 b and g WLAN devices. The primary enhancement over 802.11 devices is Mesh Network's ability to provide continuously connected data services to moving vehicles as they pass through a coverage area. Another key enhancement is Mesh Network's ability to allow each vehicle to act as a mobile repeater to enhance the overall network and to communicate directly with each other (peer to peer). Mesh Network's technology also provides an increased level of security over 802.11 networks.

Mesh Network user devices are capable of broadband data rates from 500 Kbps to 6 Mbps (burst). Typical uplink and downlink data rates will vary between 512 Kbps and 1.5 Mbps as compared to 11 Mbps to 54 Mbps for 802.11 b and g access points.

The Mesh Network solution promises the bandwidth needed to support network connectivity, video transmission, or other data intensive applications in moving vehicles. Mesh Networks has also developed a hardware/software solution to provide wide-area connectivity to fixed, portable and mobile devices. In addition to its data and video capabilities, Mesh Network enabled architecture products also support voice and location services that can be used to manage field personnel.

Similar technologies to that used by Mesh Networks are also available from other vendors such as Tropos Networks, Strix Systems, and BelAir Networks.

Motorola Canopy network technology provides a backhaul solution to wirelessly link Mesh Network access points and connect them to the primary wired network. Canopy is a point-to-point and point-to-multipoint wireless backhaul system that can be readily deployed in unlicensed 5.2 GHz and 5.7 GHz spectrum. Canopy is essentially a wireless alternative to running leased or user owned wired network connections to each access point in the system. Data backhaul is a significant issue when one considers the great numbers of access points required by a Mesh Network solution to provide blanket coverage in a given geographical area.

5.2.6.2 Cost Analysis

Implementation of a private Mesh Network solution with the possibility of hundreds of access points and backhaul requirements results in a very high implementation cost. Because of the high costs, WLAN networks are usually deployed commercially or by multi-user private entities. Access point installation locations must be determined and usually include utility and traffic light poles, building rooftops, billboard signs, etc. A 100 square mile area may require about 1,600 access points. Considering a budgetary estimated cost of $8,000.00 per access point installed, the cost may be $12.8 million dollars for infrastructure alone.

5.2.6.3 Maintenance and Other Recurring Costs

A major issue to be considered in implementation of a WLAN is communications system maintenance. Implementation of a private Mesh Network solution with the possibility of hundreds of access points and routers will result in significant system maintenance cost. Maintenance on typical conventional radio systems may exceed eight percent of the total equipment cost on an annual basis. Additionally, a system administrator will be needed to manage an extensive wireless network.

5.2.6.4 Advantages and Disadvantages

WLAN technology provides high data throughput that will support video and on-vehicle internet access, but is not well suited to wide-area mobile wireless communications (except possibly for public carriers) due to the very high number of access points that would be required to cover a large service area. The communication standards for the moving mobile environment are under development. Typically, WLAN is well suited for local area wireless communications or smaller towns. Interference is possible in the unlicensed bands.

5.3 Agency Shared Infrastructure

5.3.1 Overview

Due to the proximity of some agencies, it may be cost effective to share some infrastructure equipment and possibly base station sites. This is particularly attractive when agency service areas overlap or are in close proximity to each other.

Shared infrastructure has been considered for the following geographic areas:

- Ames / Des Moines
- University of Iowa / Coralville / Iowa City
- Davenport / Bettendorf

5.3.2 CAD/AVL Systems

CAD/AVL server equipment may be utilized to support multiple agencies. However, recurring costs for leased data lines for connection of each agency's dispatch center to the common CAD/AVL system can negate over time any initial cost benefits of a shared system.

Shared CAD/AVL may be considered for each of the geographic areas above.

5.3.3 Radio System Infrastructure

Private mobile data base station resources and sites may be shared if agencies require mobile data coverage within a common area. This may be the case with some paratransit operations but is usually rare for fixed route services.

If a leased trunked mobile data system such as the RACOM EDACS system, or a commercial carrier mobile data solution such as Verizon Wireless system is implemented, there is not a cost benefit to sharing radio system infrastructure since these systems are existing and wide-area by design.

Since a single private conventional base station may provide adequate radio coverage in a metropolitan area, shared private base stations may be considered for the University of Iowa, Coralville, and Iowa City area and the Davenport and Bettendorf area.

If the area is larger as with Des Moines and Ames, it is likely that multiple base stations would be required to provide adequate radio coverage and any benefit of shared resources would be lost especially considering the recurring leased line costs for connectivity to the remote base station sites.

5.3.4 Shared Infrastructure Summary

Equipment implementation costs may be reduced if agencies operate within closely spaced areas and can utilize a common private base station. If a leased communications system is implemented, there is little benefit for sharing system resources considering the connectivity requirements of linking dispatch centers to a common system. There is no cost saving benefit for implementation of common mobile data radio vehicle equipment.

5.4 Budgetary Cost Estimate

The budgetary cost shown in Figure , Figure and Figure estimates illustrate the differences in initial cost, recurring cost, and the 10 year cumulative costs for a conventional private UHF mobile data system with one base station, a leased trunked mobile data system such as the RACOM EDACS system, and a commercial carrier mobile data solution such as Verizon Wireless. The budgetary cost estimates are based on fifty (50) units and represents mobile data communications services only. The costs do not include voice communications.

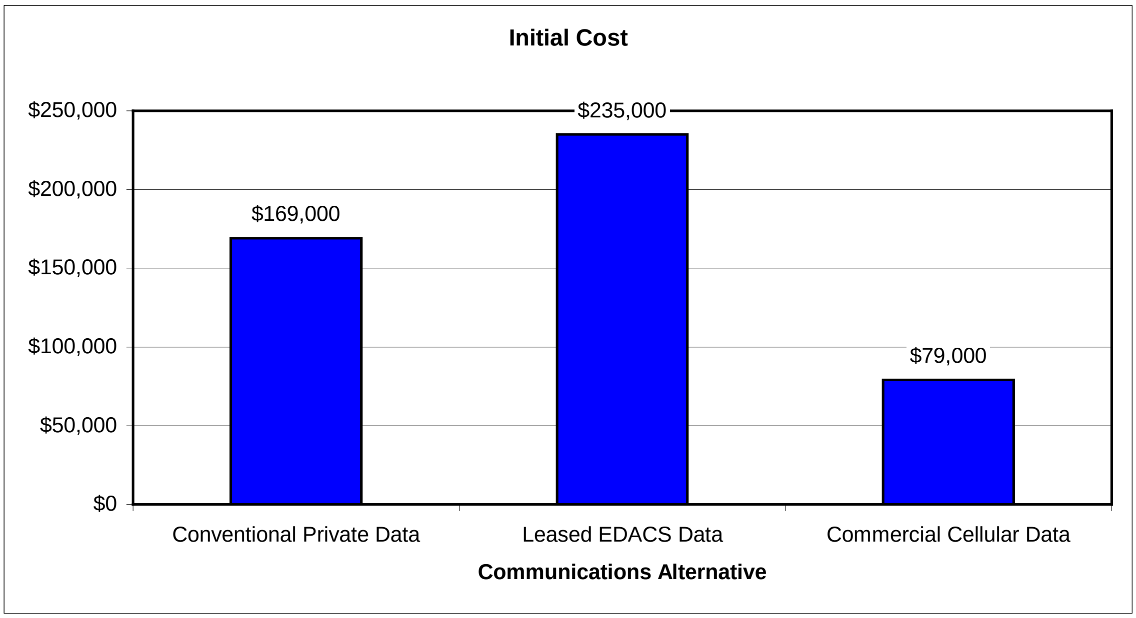

Figure 6. Budgetary Cost Estimate – Initial Cost

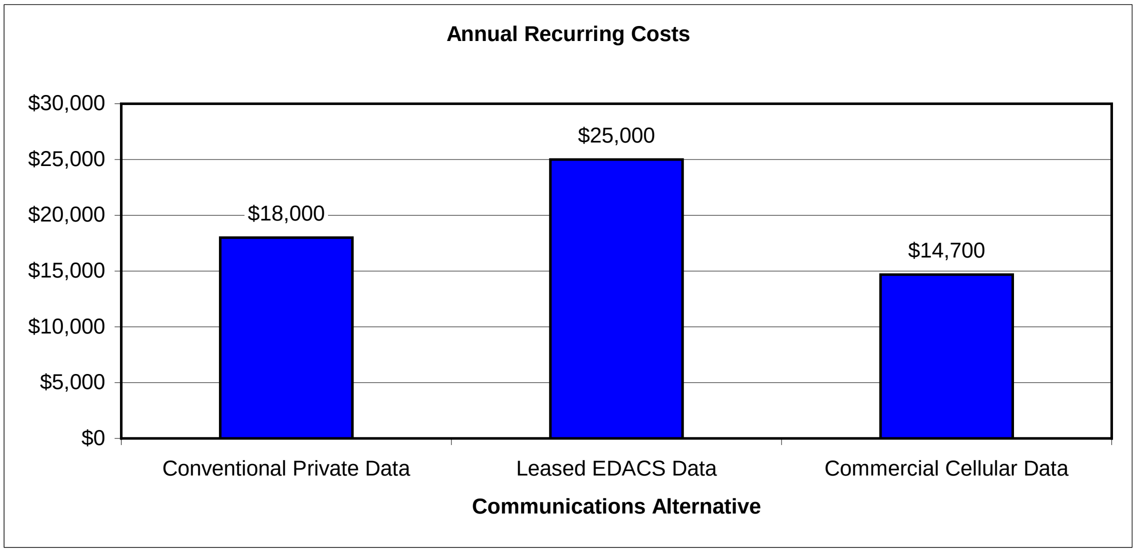

Figure 7. Budgetary Cost Estimate – Annual Recurring Costs

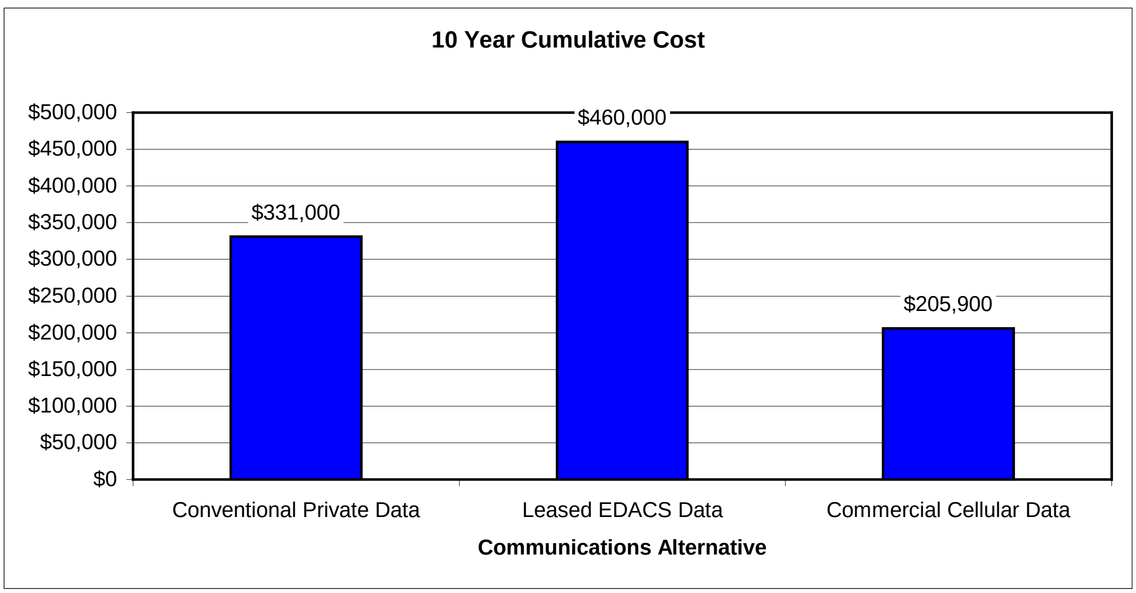

Figure 8. Budgetary Cost Estimate – 10-Year Cumulative Costs

Table 5 shows budgetary cost estimates for agencies of 10 to 120 vehicles. The budgetary cost for a private conventional mobile data system with 120 vehicles includes 2 mobile data base stations.

Table 5. Budgetary Cost Estimates for Various Agency Fleet Sizes

Technology and Agency Size	Initial Cost	Annual Recurring Costs	10-year Cumulative Costs
Private Conventional Mobile Data			
10 Vehicles	$87,000	$16,000	$231,000
20 Vehicles	$108,000	$16,000	$252,000
40 Vehicles	$149,000	$17,000	$302,000
60 Vehicles	$190,000	$19,000	$361,000
120 Vehicles	$379,000	$37,000	$712,000
Leased EDACS Mobile Data			
10 Vehicles	$47,000	$5,000	$92,000
20 Vehicles	$94,000	$10,000	$184,000
40 Vehicles	$188,000	$20,000	$368,000
60 Vehicles	$282,000	$30,000	$552,000
120 Vehicles	$564,000	$60,000	$1,104,000
Leased Verizon Wireless Mobile Data			
10 Vehicles	$15,800	$3,700	$47,300
20 Vehicles	$31,600	$5,500	$79,300
40 Vehicles	$63,200	$11,000	$158,600
60 Vehicles	$94,800	$16,500	$237,900
120 Vehicles	$189,600	$33,000	$475,800

Budgetary cost estimates were not developed for a WLAN option. A WLAN implementation must be carefully engineered based on the agency's local environment and will be greatly affected by the area of operation, local terrain and building clutter, available access point installation structures, available backhaul connectivity such as fiber, microwave, or other existing network infrastructure, etc.. Implementation of a WLAN that would cover the same area as a single UHF base station or trunked EDACS site could cost several million dollars.

5.5 Recommended Technologies

5.5.1 Overview

There are several criteria that must be considered when selecting a communications technology. Communications system requirements vary based on the specific characteristics and needs of each agency. The primary considerations are as follows:

- Agency fleet size
  - Area of operation
  - Fixed route

  - Paratransit
  - Special services

- Area geography (flat terrain or mountainous)
- Availability of sharing existing systems
- Availability of radio frequencies and tower sites
- Availability of commercial carrier options
- Radio coverage of commercial carriers
- Ability for system expansion (capacity and/or radio coverage)
- Selected ITS technologies
- Initial and recurring costs (maintenance, tower site lease, leased lines, etc)

5.5.2 Recommendation

Commercial cellular carriers offer rapid implementation, higher bandwidth, low cost monthly government rate plans, low cost equipment, reliable service, low maintenance cost, good radio coverage in urban areas and along major highways, and the availability of multiple agencies to operate on a common infrastructure if desired. For most agencies, the cellular option is the recommended technology if the cellular carrier provides adequate radio coverage. Coverage should be verified before implementation of a cellular solution, and should include field testing in the agency's service area.

For larger agencies with several hundred vehicles, or agencies with tower site resources, a private communications system may be better suited due to the increasing recurring costs associated with monthly system access fees.

If the radio coverage of a commercial cellular carrier is inadequate, then a private conventional communications system or a commercial leased solution such as RACOM's EDACS system may be considered.

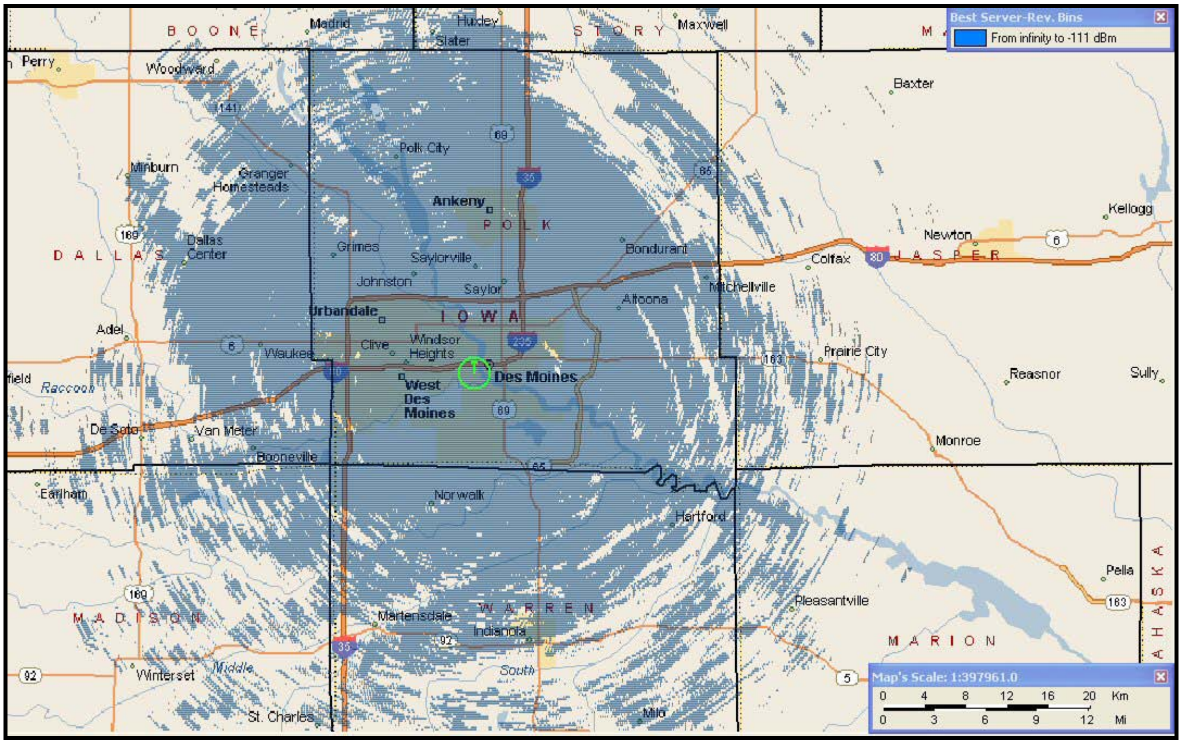

Figure 9. Conventional UHF Coverage in Des Moines

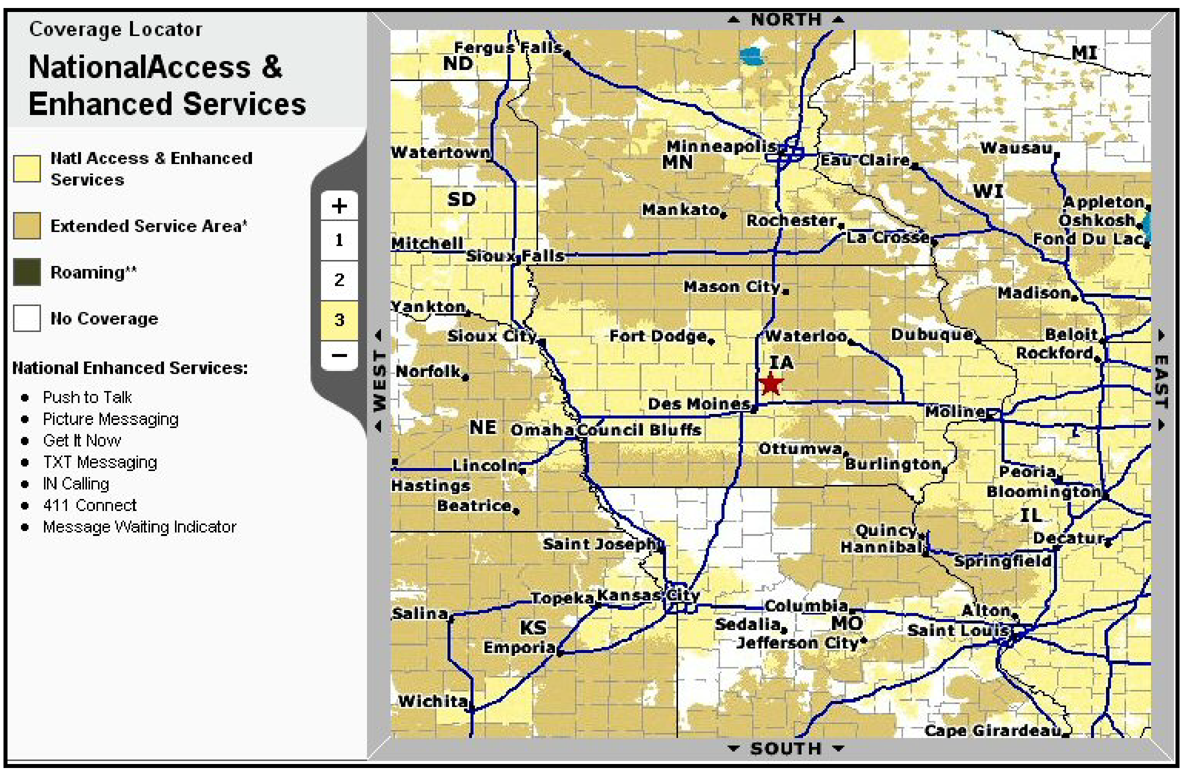

Figure 10. Verizon Wireless Coverage in Iowa

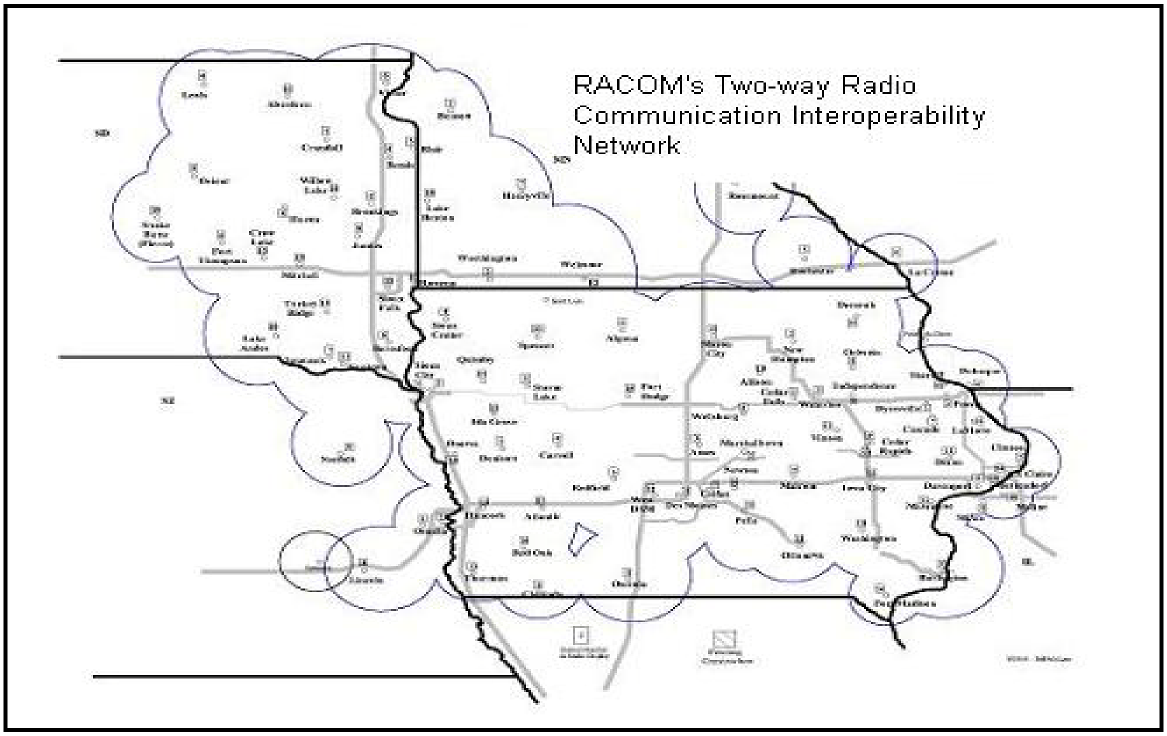

Figure 11. RACOM EDACS Coverage in Iowa

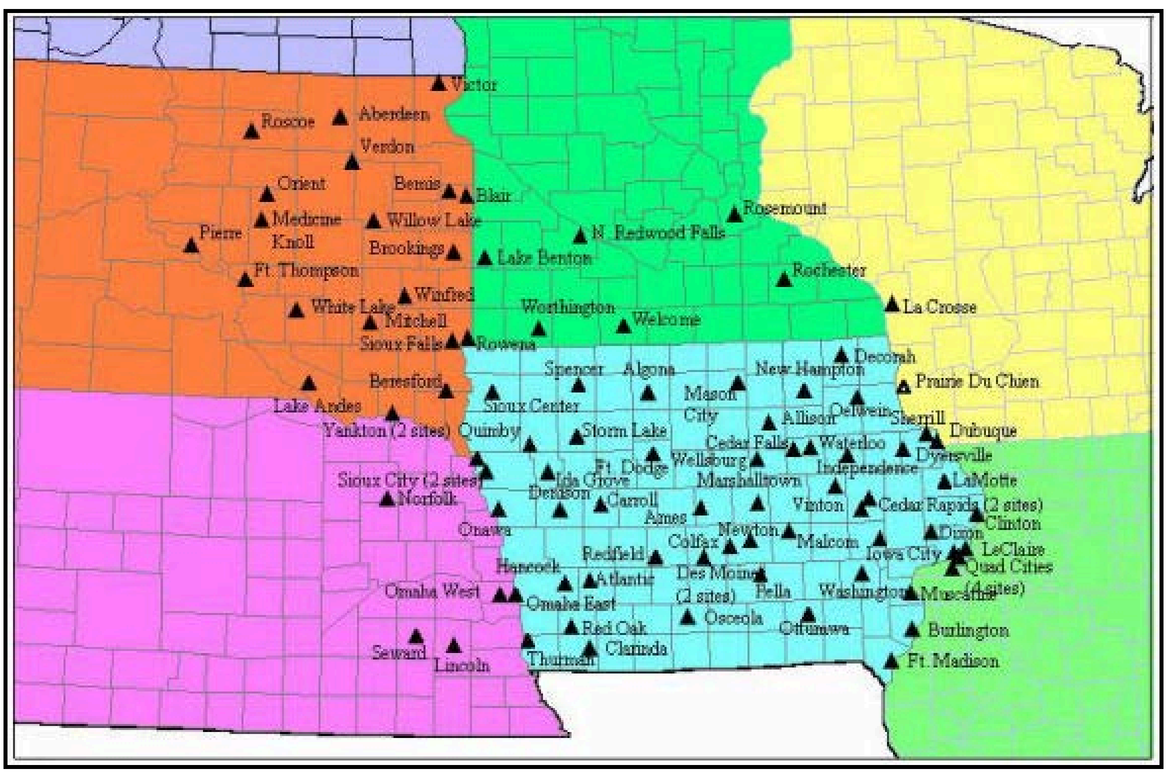

Figure 12. RACOM EDACS Tower Sites in Iowa

6. Recommended ITS Deployments

This section discusses the recommended ITS technologies to be deployed at the participating large urban transit systems. The first subsection, "Summary of Desired Transit ITS Technologies," provides a summary of agencies' needs and their desired enhancements. The next subsection, "Individual Agency Needs," discusses each agency's prioritized needs, deployments timeframe and recommended technologies. The cost, benefits and organizational impacts of these deployments is also included.

6.1 Summary of Desired Transit ITS Technologies

Based on the results of the Needs Assessment, the TranSystems Team recommends specific ITS technologies to meet the agencies' identified needs. Table 6 on the following page lists the areas of needs along with desired enhancements and applicable ITS technologies to address these needs.

6.2 Individual Agency Needs

To prioritize technology needs within each transit agency the Steering Committee participated in an exercise to evaluate and rank the identified needs. Each Steering Committee member was given 48 chits to be used to indicate the relative importance of each need. The agency managers were directed to assign the number of chits to each need that represented their thinking on priority. Because the number of chits was limited, the managers were required to make decisions about the relative importance of each need and how needs, and the related ITS solutions, relate to each other. The exercise was conducted in a group setting after the evaluation of individual agency needs and sessions on available technology. Thus, the "decisions" made by the managers were informed decisions.

Exercises such as this are used frequently as a means to establish priorities among a number of competing, but not mutually exclusive, courses of action. The result of the exercise was a scoring or numerical rating of transit agency needs as shown in the tables in this section of the report.

The agency managers were also asked to define the timeframe the needs should be addressed. The timeframe could be a function of priority or importance, but also funding considerations and other projects or activities ongoing at the transit agency. Please note that the Timeframe column in the tables refers to the following: Short is 1-3 years, Medium is 3-5 years and Long is over 5 years.

Table 6. Summary of Large Urban Transit Systems Needs

Current Need/Issue	Agency	Desired Enhancement
	Operations	
Dispatchers have a need for more specific information on the location of buses in service, and bus location relative to schedules.	Black Hawk County Cambus CitiBus Coralville Transit System CyRide DART Five Seasons Transportation Iowa City Transit Sioux City	Monitor location of buses in real-time.
Dispatchers need to have access to schedules and other operating materials electronically.	DART	Interface scheduling system with dispatch system.
On-time performance is about 90%.	Iowa City Transit	Further improve on-time to mid to high 90%.
There is a need for better coordination of transfers	Black Hawk County	Automate transfer requests process.
	Maintenance	
There is a need for more accurate automated record keeping.	Coralville Transit System	Automate record keeping
There is a need for modern update software systems.	DART Sioux City Transit	Need for a software that meets agency's needs and to interface with their payroll system.
Current Need/Issue	**Agency**	**Desired Enhancement**
	Scheduling	
Automation for schedule creation is needed.	Cambus	Automate creation of schedules.
There is a need for an automated assist for driver Rostering.	DART	Customize Trapeze FX to create a roster for fixed-route.
	Planning	
Automation is needed to avoid intensive labor involved in collecting and entering ridership data	Black Hawk County Cambus CyRide DART Five Seasons Transportation Iowa City Transit Sioux City Transit	Enhance ridership data collection.

Table 6. Summary of Large Urban Transit Systems Needs (continued)

Current Need/Issue	Agency	Desired Enhancement
Customer Information		
Congestion and weather disrupt the service quite frequently.	Cambus	Provide customer service staff and riders with up to the minute information about the service.
Riders are not aware of where buses are.	CitiBus Coralville Transit System Sioux City Transit	
Customer service center is overwhelmed with calls about bus delays and other information.	CyRide DART Five Seasons Transportation Iowa City Transit	
Automated next stop announcements are needed for improved customer service.	Black Hawk County CitiBus Coralville Transit System Five Seasons Transportation Iowa City Transit Sioux City	Need for an automated system.
Finance		
Existing fareboxes are old and do not provide required information about fares	Black Hawk County CitiBus Iowa City Transit Sioux City Transit	Need for improved fareboxes to track fares. Interested in a smart card system.
Security/Safety		
Existing onboard surveillance cameras are inadequate in terms of data storage and capacity.	CitiBus	The system may need to be replaced with one that meets the agency's needs. Add exterior cameras as well.
Improved onboard surveillance is needed.	Coralville Transit System DART A Iowa City Transit	There is a need for onboard cameras.
Lack of adequate facility surveillance.	DART	Need to provide facility surveillance
Other		
Training 80 drivers a year (student employees) is costly and time consuming.	Cambus CitiBus	Reduce time and effort needed in training drivers without reducing quality of training

6.2.1 Ames-CyRide

CyRide's specific needs are summarized in Table 7.

Table 7. Ames CyRide Needs in Order of Priority

	Description	Rating	Timeframe
1	Dispatchers need to know where buses are in real-time to better manage on-street operations, particularly on high service high volume routes.	22	Short
2	Need for daily ridership information, possibly real-time to adjust service levels.	14	Short
3	Need to provide real-time data on the internet to reduce dispatchers' burden in responding to information calls.	8	Medium
4	Need to provide real-time data at stop kiosks to lessen dispatchers' burden in responding to information calls.	4	Medium-Long

The TranSystems Team recommends deploying technologies in two phases as shown in Table 8. The first phase (1-3 years timeframe) will include CAD/AVL and automatic passenger counting (APC) systems, which were scored as the most critical. The second phase will include the deployment of advanced traveler information systems on the Internet and at bus stops (wayside). The Internet application will provide users with real-time information regarding where the buses are while the wayside system will provide information on the expected arrival/departure time of buses.

Table 8. Phasing of Recommended ITS Deployments for Ames CyRide*

Phase	Rating	Timeframe	Technology	Need Addressed
Phase 1	22	Short	CAD/AVL	1,3,4
	14	Short	APC	2
	*	Short	Automated Annunciation	*
Phase 2	8	Medium	ATIS (on Internet)	3
	*	Medium	Electronic Payment Systems	*
	4	Medium-Long	ATIS (at stops)	4

***** Automated annunciation and EPS were not ranked because they were added after the prioritization exercise took place.

Table 9 summarizes the expected deployment cost of the recommended technologies for Ames CyRide. Please note that typically, an AVL system is deployed as a bundle that also includes CAD system. Hence, CAD and AVL are shown as one item in the following table.

Because of the wide ranges in some of the cost figures for many of the recommended technologies, an additional set of columns in the cost tables was added to indicate the most likely cost that will be incurred by each agency.

Table 9. Estimated Cost for Cyride Recommended ITS Deployments

Technology	Unit	Capital Cost		Most Likely Cost	
		Low	High	Capital	O&M
EPS	63 vehicles	$978,500	$1,454,500	$1,155,000	$53,531
APC System	20 vehicles	$105,000	$155,000	$135,000	$9,300
CAD/AVL	63 vehicles	$717,400	$1,187,450	$923,000	$60,220
Automatic Annunciation	63 vehicles	$345,500	$563,000	$475,000	$28,208
Real-Time Information	10 signs	$80,000	$155,000	$135,000	$9,300
Web-Based Real-Time Info	system	$59,000	$113,000	$81,000	$8,100
Total		**$2,285,400**	**$3,627,950**	**$2,904,000**	**$168,658**

6.2.2 City of Bettendorf

The City of Bettendorf did not take part in the Needs Assessment. The City is currently implementing transit ITS technologies as part of a broader ITS program.

6.2.3 Cedar Rapids-Five Seasons Transportation

Cedar Rapids' specific needs are summarized in Table 10.

Table 10. Cedar Rapids Needs in Order of Priority

	Description	Rating
1	Dispatchers need to know where buses are in real-time to better manage on-street operations.	N/A*
2	Need a more efficient communication system.	12
3	Need for an automated passenger counting system.	12
4	Need for announcements of bus locations and arrival times to be automated to comply with ADA requirements.	12
5	Need for web-based user information with itinerary planning targeted to potential riders	12

*A CAD/AVL system is already in place, thus a priority rating is not applicable.

Because Cedar Rapids already has a CAD/AVL system in place and is planning on upgrading it in the near future, it was assumed that AVL data will be available for the other ITS technologies recommended for Cedar Rapids in this report. It is highly recommended that Cedar Rapids upgrade its communications system before upgrading the CAD/AVL system. Once communications and CAD/AVL systems are upgraded, Cedar Rapids may proceed with Phase 2, as shown in Table 11, which includes the deployment of APC, automatic annunciation and advanced traveler information systems. The Internet application will provide users with real-time information regarding current bus location, as well as the means to generate trip itineraries.

Table 11. Phasing of Recommended ITS Deployments for Cedar Rapids

Phase	Rating	Technology	Need Addressed
Phase 1	12	Communications	2
Phase 2	12	APCs	3
	12	Automated Annunciation	4
	12	ATIS (web info. & Itinerary)	5

Table 12 summarizes the expected deployment cost of the recommended technologies for Cedar Rapids.

Table 12. Estimated Cost for Cedar Rapids Recommended ITS Deployments

		Capital Cost		Most Likely Cost	
Technology	**Unit**	**Low**	**High**	**Capital**	**O&M**
APC System (with GPS)	5 vehicles	$65,000	$100,000	$85,000	$6,400
Automatic Annunciation	11 vehicles	$126,000	$188,000	$180,000	$13,323
Web-Based Real-Time Information	system	$34,000	$58,000	$45,000	$4,500
Total		**$225,000**	**$346,000**	**$310,000**	**$24,223**

6.2.4 Coralville Transit

Coralville's specific needs are summarized in Table 13.

Table 13. Coralville Needs in Order of Priority

	Description	Rating	Timeframe
1	Dispatchers need to know where buses are in real-time to better manage on-street operations.	20	Short
2	Need to provide arrival time information at common transfer points to retain user confidence and facilitate transfers with other systems.	14	Short
3	Need for web-based user information with access to real time information targeted at the metro area's largely choice market.	10	Short
4	Need for new fareboxes that can use smart card technology to facilitate travel among the three transit systems.	4	Medium
5	Need to automate maintenance record keeping.	0	Long
6	The radio system needs to be upgraded to permit select call and to improve coverage voids.	0	Long

The two major concerns for Coralville are managing their fleet in real-time and providing better information to their riders. Hence, the TranSystems Team recommends deploying a CAD/AVL system in the first phase (1-3 years timeframe) as shown in Table 14. The recommended CAD/AVL system will also include transfer connection protection (TCP) functionality to facilitate transfers between the Coralville system, and Cambus and Iowa City systems. Phase 1 also includes the deployment of a web application to provide real-time location of the buses on a map. Although providing real-time arrival information at bus stops was ranked higher than the web application, TranSystems recommends making it part of Phase 2 to ensure that the CAD/AVL system is in place and is operating consistently (providing inaccurate arrival times will result in the erosion of the riders' confidence in the system). Phase 2 will also include the deployment of new fareboxes.

Table 14. Phasing of Recommended ITS Deployments for Coralville

Phase	Rating	Timeframe	Technology	Need Addressed
Phase 1	20	Short	CAD/AVL	1,2,3
	10	Short	ATIS (on Internet)	3
Phase 2	14	Short	ATIS (at stops)	2
	4	Medium	Electronic Payment Systems	4
Phase 3	0	Long	Maintenance Management Software	5
	0	Long	Communications	6

Table 15 summarizes the expected deployment cost of the recommended technologies for Coralville.

Table 15. Estimated Costs for Coralville Recommended ITS Deployments

Technology	Unit	Capital Cost		Most Likely Cost	
		Low	High	Capital	O&M
EPS	11 vehicles	$224,500	$336,500	$275,000	$13,469
AVL/CAD/MDT	11 vehicles	$421,800	$611,000	$483,000	$32,720
Real-Time Info.	10 signs	$80,000	$155,000	$135,000	$9,300
Maintenance Management System	system	$215,000	$420,000	$215,000	$20,623
Web-Based Real-Time Information	system	$59,000	$113,000	$81,000	$8,100
Total		**$1,000,300**	**$1,635,500**	**$1,189,000**	**$84,212**

6.2.5 Davenport CitiBus

Davenport's specific needs are summarized in Table 16.

Table 16. Davenport Needs in Order of Priority

	Description	Rating	Timeframe
1	Need to provide dispatchers with real time data to better manage on-street operations.	8	Short
2	Need to improve access to security data by changing the method of processing video data from onboard cameras.	8	Short
3	Need to equip fleet with two cameras for outside vehicle surveillance.	8	Short
4	Need for web-based user information targeted to potential riders from St. Ambrose University.	8	Short
5	Need to upgrade fareboxes to utilize smart card technology and allow better tracking of fares.	6	Medium
6	Reduce the time burden of driver training through use of a simulator.	6	Medium
7	Need for announcements of bus locations and arrival times to be automated to comply with ADA requirements.	4	Medium

Given Davenport's desire to further improve its service efficiency, revenue and security, the recommended technologies should be deployed in two phases as shown in Table 17. Phase 1 (1-3 years timeframe) will include CAD/AVL and automated annunciation systems, and on-board cameras. Once the CAD/AVL system is deployed, which is the backbone to other ITS deployments, Phase 2 may be deployed which includes the web application and smart-card-based fareboxes, both of which will need to interface with the CAD/AVL system. A driving simulator is also included as part of Phase 2.

Table 17. Phasing of Recommended ITS Deployments for Davenport

Phase	Rating	Timeframe	Technology	Need Addressed
Phase 1	8	Short	CAD/AVL	1
	8	Short	Cameras	2,3
	4	Medium	Automated Annunciation	7
Phase 2	8	Short	ATIS (on web)	4
	6	Medium	EPS	5
	6	Medium	Simulator	6

Table 18 summarizes the expected deployment cost of the recommended technologies.

Table 18. Estimated Cost for Davenport Recommended ITS Deployments

Technology	Unit	Capital Cost		Most Likely Cost	
		Low	High	Capital	O&M
EPS	20 vehicles	$355,000	$530,000	$430,000	$20,200
AVL/CAD/MDT	20 vehicles	$436,000	$727,000	$483,000	$30,320
Automatic Annunciation	20 vehicles	$155,000	$245,000	$245,000	$17,485
Enhancing and Augmenting On-Board Cameras	20 vehicles	$50,000	$70,000	$50,000	$2,000
Web-Based Real-Time Information	system	$59,000	$113,000	$91,000	$9,100
Driving Simulator	system	TBD	TBD	$500,000	TBD
Total		**$1,055,000**	**$1,685,000**	**$1,799,000**	**$79,105**

6.2.6 Des Moines Area Regional Transit Authority (DART)

DART's specific needs are summarized in Table 19.

Table 19. DART's Needs in Order of Priority

	Description	Rating A*	Rating B*	Timeframe
1	Need to upgrade the automated systems in vehicle maintenance.	9	3	Short
2	Need to train paratransit staff how to use current paratransit software.	2	5	Short
3	Need to augment current security capability.	4	No rating	Short
4	Establish data communication for paratransit fleet integrated with current paratransit operations software.	N/A	3	Short
5	Dispatchers need to know where buses are in real-time to better manage on-street operations and improve reliability.	11	9	Medium
6	Need to provide call takers with real-time information of where buses are.	12	5	Medium
7	Need to provide real time information at transit centers and stops.	8	9	Medium
8	Need to provide customers with an automated itinerary service.	2	7	Medium
9	Need for fixed route scheduling software and CAD system to be interfaced.	N/A	4	Medium
10	Need for an automated annunciation system.	0	1	Medium
11	Need to collect and compile ridership data more easily.		1	Long
12	Need for fareboxes that accept different methods of payment.	0	1	Long

Note: * Rating A is from the General Manager; Rating B is from Staff.
The TranSystems Team recommends deploying technologies in three phases as shown in Table 20.

The *first phase* (1-3 years timeframe) will include CAD/AVL and maintenance management systems. Training on scheduling software should be undertaken as soon as possible. The *second phase* (3-5 years timeframe) will include the deployment of advanced traveler information systems. These include providing real-time information on the location of buses to call takers and on the Internet, providing real-time arrival information at bus stops and a trip itinerary planning application on the Internet. Although DART staff ranked the provision of real-time information higher than some of the systems included in Phase 1, they were nonetheless moved to Phase 2 as a CAD/AVL system will need to be in place before providing real-time information. The *third phase* includes deploying an APC system, automatic annunciation system and new fareboxes.

Table 20. Phasing of Recommended ITS Deployments for DART

Phase	Rating A*	Rating B*	Timeframe	Technology	Need Addressed
Phase 1	9	3	Short	Maintenance Management Software	1
	2	5	Short	Training	2
	**	**	Short	On-Board Cameras	3
	11	9	Medium	CAD/AVL	4,5,6,7,9
Phase 2	12	5	Medium	ATIS (real-time info. to call takers)	6
	8	9	Medium	ATIS (at stops)	7
	2	7	Medium	ATIS (web itinerary planning)	8
Phase 3	0	1	Medium	Automated Annunciation	10
		1	Long	APC	11
	0	1	Long	EPS	12

Notes: * Rating A is from the General Manager; Rating B from Staff.
** Onboard cameras are not ranked because they were added after the consensus building took place.

Table 21 summarizes the expected deployment cost of the recommended technologies for DART.

Table 21. Estimated Cost for DART Recommended ITS Deployments

Technology	Unit	Capital Cost		Most Likely Cost	
		Low	High	Capital	O&M
EPS	118 vehicles	$1,776,000	$2,637,000	$2,010,000	$92,262
APC System	30 vehicles	$130,000	$195,000	$165,000	$10,500
AVL/CAD/MDT	118 vehicles	$868,400	$1,470,700	$1,160,000	$68,200
Automatic Annunciation	118 vehicles	$538,000	$893,000	$745,000	$39,423
Real-Time Information	20 signs	$110,000	$235,000	$165,000	$10,500
Maintenance Management System	system	$415,000	$720,000	$520,000	$50,831
On-Board Cameras	80 vehicles	$400,000	$560,000	$450,000	$18,000
Web-Based Real-Time Information	system	$59,000	$113,000	$101,000	$10,100
Total		**$4,296,400**	**$6,823,700**	**$5,316,000**	**$299,815**

6.2.7 City of Dubuque-Keyline Transit

Dubuque's specific needs are summarized in Table 22.

Table 22. Dubuque Needs in Order of Priority

	Description	Rating	Timeframe
1	Dispatchers need to know where buses are in real-time to better manage on-street operations and improve on-time performance.	20	Short
2	Need to equip fleet with cameras for in-vehicle surveillance.	10	Short
3	Need to collect and compile ridership data more easily.	5	Medium
4	Need for an automated annunciation system on buses.	5	Medium
5	Need for electronic payment system onboard vehicles.	5	Medium
6	Need to automate maintenance record keeping.	3	Medium

The recommended technologies for Dubuque may be deployed in two or three phases (hence the use of Phase 1a and 1b) as shown in Table 23. A CAD/AVL system and on-board cameras are to be deployed first not only because they were ranked as the highest priorities but also because other ITS technologies will need to interface with the CAD/AVL system to capture location data. However, if funding is available to deploy both APC and automatic annunciation systems as part of the CAD/AVL procurement, that will result in cost savings. Otherwise, APC and automatic annunciation systems may be deployed in the second phase. The third phase includes deployment of an EPS and maintenance management software.

Table 23. Phasing of Recommended ITS Deployments for Dubuque

Phase	Rating	Timeframe	Technology	Need Addresses
Phase 1a	20	Short	CAD/AVL	1
	10	Short	Cameras	2
Phase 1b	5	Medium	APC	3
	5	Medium	Automated Annunciation	4
Phase 2	5	Medium	EPS	5
	3	Medium	MMIS	6

Table 24 summarizes the expected deployment cost of the recommended technologies for Dubuque.

Table 24. Estimated Cost for Dubuque Recommended ITS Deployments

Technology	Unit	Capital Cost		Most Likely Cost	
		Low	High	Capital	O&M
EPS	12 vehicles	$239,000	$358,000	$292,000	$14,000
APC System	4 vehicles	$67,000	$95,000	$85,000	$7,300
AVL/CAD/MDT	12 vehicles	$375,600	$538,000	$418,000	$25,920
Automatic Annunciation	12 vehicles	$167,000	$257,000	$190,000	$15,200
Maintenance Management System	system	$210,000	$415,000	$215,000	$20,623
On-Board Cameras	12 vehicles	$60,000	$84,000	$70,000	$2,800
Total		**$1,118,600**	**$1,747,000**	**$1,270,000**	**$85,843**

6.2.8 Iowa City Transit

Iowa City's specific needs are summarized in Table 25.

Table 25. Iowa City Needs in Order of Priority

	Description	Rating	Timeframe
1	Dispatchers need to know where buses are in real-time to better manage on-street operations.	24	Short
2	Need to provide real-time data at bus stops.	12	Medium
3	Need to automate itineraries for customers.	6	Medium
4	Need for new fareboxes that can use smart card technology.	4	Medium
5	Need to retrofit ten buses with onboard cameras to monitor conditions and behavior on buses.	2	Likely to be funded outside of project
6	Need to automate maintenance record keeping, including major components.	0	
7	Need for an automated passenger counting system.	0	Nice, maybe 1 or 2 units
8	Need to access real-time data on bus location.		

It is recommended that the ITS technologies be deployed in three phases as shown in Table 26. The first phase (1-3 years timeframe) will include a CAD/AVL system, which includes TCP functionality to facilitate transfers between the Iowa City system, and Cambus and Coralville systems. Phase 1 also includes the deployment of a web application to provide trip itinerary planning. Although providing real-time arrival information at bus stops was ranked higher than the web application, TranSystems recommends making web application part of Phase 2 to ensure that the CAD/AVL system is in place and is operating consistently before putting out any real-time information. Phase 2 (3-5 years timeframe) includes the deployment of an advanced traveler information system to provide real-time arrival information at bus stops, as well as an EPS. On-board cameras, a maintenance management system and APCs are included in Phase 3 (beyond five years). However, if Coralville is interested in deploying APCs, it may want to consider deploying it as part of Phase I to realize savings in deployment costs by making it part of the CAD/AVL deployment.

Table 26. Phasing of Recommended ITS Deployments for Iowa City

Phase	**Rating**	**Timeframe**	**Technology**	**Needs Addressed**
Phase 1	24	Short	CAD/AVL	1,2
	6	Medium	ATIS (web itinerary planning)	3
Phase 2	12	Medium	ATIS (at stops)	2
	4	Medium	EPS	4
Phase 3	2	Likely to be funded outside of project	Cameras	5
	0	Nice, may be 1 or 2 units	APC**	7
	0		MMIS	6

** Coralville Transit may want to consider deploying APC as part of Phase I. Making it part of the CAD/AVL deployment will result is cost savings.

Table 27 summarizes the expected deployment cost of the recommended technologies for Iowa City.

Table 27. Estimated Cost for Iowa City Recommended ITS Deployments

Technology	Unit	Capital Cost		Most Likely Cost	
		Low	High	Capital	O&M
EPS	23 vehicles	$398,500	$594,500	$478,000	$22,486
APC System	8 vehicles	$75,000	$107,000	$97,000	$7,780
AVL/CAD/MDT	23 vehicles	$497,400	$826,950	$563,000	$37,720
Real-Time Information	10 signs	$55,000	$130,000	$100,000	$6,400
Maintenance Management System	system	$215,000	$420,000	$215,000	$20,623
On-Board Cameras	41 vehicles	$115,000	$161,000	$150,000	$6,000
Web-Based Real-Time Information	system	$34,000	$88,000	$91,000	$6,600
Total		**$1,389,900**	**$2,327,450**	**$1,694,000**	**$107,609**

6.2.9 City of Sioux City

Sioux City's specific needs are summarized in Table 28.

Table 28. Sioux City Needs in Order of Priority

	Description	Rating	Timeframe
1	Need for different fareboxes to better track fares and allow the use of stored value card system.	12	Short
2	Need to automate the collection of ridership data.	9	Short
3	Need to have improved real-time tracking of vehicles	8	Short
4	Need to automate the process of creating drivers' picks.	6	Short
5	Need to automate on-board annunciations.	5	Short
6	Need to monitor bus components in real time.	4	Short
7	Need to display transit information on kiosks.	3	Medium
8	Need to replace current MMIS software.	0	Long

Technologies recommended for Sioux City may be deployed in three or four phases depending on funding as shown in Table 29. Phase 1a includes new fareboxes (EPS) for the fleet and a new scheduling software. Both of these systems do not require a CAD/AVL system to be in place prior to their deployments. If funding permits, deploying the systems in Phase 1b at the same time as Phase 1a will result in cost savings to Sioux City. Phase 2 (3-5 years timeframe) includes the provision of real-time arrival information at bus stops, which requires a CAD/AVL system to be in place. A new maintenance management system received zero (0) points and hence was included in Phase 3 (beyond five years).

Table 29. Phasing of Recommended ITS Deployments for Sioux City

Phase	Rating	Timeframe	Technology	Need Addressed
Phase 1a	12	Short	EPS	1
	6	Short	Scheduling System	4
Phase 1b	9	Short	APC	2
	8	Short	CAD/AVL	3,6
	5	Short	Automated Annunciation	5
	4	Short	Vehicle Component Monitoring	6
Phase 2.	3	Medium	ATIS (on kiosks)	7
Phase 3.	0	Long	MMIS	8

Table 30 summarizes the expected deployment cost of the recommended technologies for Sioux City.

Table 30. Estimated Cost for Sioux City Recommended ITS Deployments

Technology	Unit	Capital Cost		Most Likely Cost	
		Low	High	Capital	O&M
Electronic Payment System	22 vehicles	$384,000	$573,000	$500,000	$24,862
Fixed-Route Scheduling Software	system	$100,000	$150,000	$150,000	$14,400
APC System	12 vehicles	$85,000	$123,000	$110,000	$8,300
AVL/CAD/MDT	22 vehicles	$520,600	$853,300	$703,000	$52,020
Automatic Annunciation	22 vehicles	$202,000	$317,000	$255,000	$19,069
Real-Time Info.	10 kiosks	$80,000	$155,000	$125,000	$8,900
Maintenance Management System	system	$210,000	$415,000	$265,000	$25,623
Total		**$1,581,600**	**$2,586,300**	**$2,108,000**	**$153,174**

6.2.10 University of Iowa-Cambus

Cambus' specific needs are summarized in Table 31.

Table 31. Cambus Needs and Recommended Technology in Order of Priority

	Description	Rating	Timeframe	Technology
1	Need to manage on time performance and headways during periods of bad weather or traffic congestion.	22	Short	CAD/AVL
2	Ridership information is needed by trip and stop to allow immediate service evaluation.	10	Short	APC
3	A more efficient process is needed for preparing and maintaining route schedules that change significantly several times each year.	8	Short	Scheduling Software
4	Service disruptions result in schedules that should be communicated to riders at high volume stops.	6	Medium	ATIS
5	Use of student drivers results in high turnover and the need to train hundreds of drivers on an ongoing basis.	2	Long	Driving Simulator

TranSystems recommends deploying the recommended technologies in two phases as shown in Table 32. The first phase (1-3 years timeframe) will include CAD/AVL and APC systems, and scheduling software, which were scored as the most critical. The CAD/AVL system also includes TCP functionality to facilitate transfers between Cambus, and Iowa City and Coralville systems. The second phase will include the deployment of an advanced traveler information system to provide real-time arrival information at bus stops. A driving simulator is included in Phase 3 based on its ranking by Cambus staff.

Table 32. Phasing of Recommended ITS Deployments for Cambus

Phase	Rating	Timeframe	Technology	Need Addressed
Phase 1	22	Short	CAD/AVL	1
	8	Short	Scheduling Software	3
	10	Short	APC	2
Phase 2	6	Medium	ATIS (at stops)	4
Phase 3	2	Long	Driving Simulator	5

Table 33 summarizes the expected deployment cost of the recommended technologies for Cambus.

Table 33. Estimated Cost for Cambus Recommended ITS Deployments

Technology	Unit	Capital Cost		Most Likely Cost	
		Low	High	Capital	O&M
Fixed-Route Scheduling Software	system	$100,000	$150,000	$150,000	$14,400
APC System	12 vehicles	$85,000	$123,000	$97,000	$7,780
AVL/CAD/MDT	32 vehicles	$431,600	$786,800	$563,000	$37,720
Real-Time Info.	10 signs	$80,000	$155,000	$125,000	$8,900
Driving Simulator	system	TBD	TBD	$500,000	TBD
Total		**$696,600**	**$1,214,800**	**$1,435,000**	**$68,800**

6.2.11 Waterloo—Black Hawk County

Waterloo's specific needs are summarized in Table 34.

Table 34. Waterloo Needs and Recommended Technology in Order of Priority

	Description	Rating	Timeframe	Technology
1	Need to improve ridership data collection.	17	Short	APC
2	Need for electronic fareboxes to help track fares.	14	Medium	Fareboxes
3	Need to make next-stop announcements at stops.	10	Medium	Automated Annunciation
4	Need for less communication between paratransit drivers and dispatch and a need for an AVL system.	7	Long	Comm. CAD/AVL

Recommended ITS technologies for Waterloo may be deployed in three phases as shown in Table 35 on the next page.

Table 35. Phasing of Recommended ITS Deployments for Waterloo

Phase	Rating	Timeframe	Technology	Need Addressed
Phase 1	14	Medium	EPS	2
Phase 2	7	Long	Comm. CAD/AVL	4

	17	Short	APC	1
Phase 3	10	Medium	Automated Annunciation	3

There is a strong need for new fareboxes to help Waterloo better track fares. Therefore that was included in Phase 1. Although an APC system was considered a higher priority than fareboxes, APC was made as part of Phase 2 because it will need to interface with a CAD/AVL system. In addition to an APC system, Phase 2 also includes the deployment of a new communications system and CAD/AVL system. Phase 3 includes the deployment of an automatic annunciation system. It is important to note that in order to deploy an automatic annunciation system, a CAD/AVL system should be in place first. Waterloo may want to consider deploying the annunciation system as part of Phase 2 if funding is available.

Table 35. Phasing of Recommended ITS Deployments for Waterloo

Phase	Rating	Timeframe	Technology	Need Addressed
Phase 1	14	Medium	EPS	2
Phase 2	7	Long	Comm. CAD/AVL	4
	17	Short	APC	1
Phase 3	10	Medium	Automated Annunciation	3

Table 36 summarizes the expected deployment cost of the recommended technologies for Waterloo.

Table 36. Estimated Cost for Waterloo Recommended ITS Deployments

Technology	Unit	Capital Cost		Most Likely Cost	
		Low	High	Capital	O&M
Electronic Payment System	15 Vehicles	$282,500	$422,500	$340,000	$16,169
APC System	6 vehicles	$70,000	$99,000	$89,000	$7,460
AVL/CAD/MDT	15 vehicles	$417,000	$693,750	$458,000	$29,320
Automatic Annunciation	15 vehicles	$177,500	$275,000	$205,000	$15,823
Total		**$947,000**	**$1,490,250**	**$1,092,000**	**$68,772**

6.3 Summary of Recommended Deployments

Table 37 lists the existing technologies and those recommended for deployment, as discussed in this document. Table 38 lists the recommended technologies by agency. The table is organized by phase of deployment and by region. This will help in realizing any procurement synergies.

Table 39 summarizes the overall cost of all the recommended ITS technologies. It is important to note that the cost tables do not include cost of communications systems replacement or upgrades.

Table 37. Summary of Recommended (✔) and Existing (E) Technologies

Agency	Recommended Technology											
	CAD/AVL	APC	ATIS (web)	ATIS (itinerary planning)	ATIS (at stop)	Automatic Annunciation	Electronic Payment System (EPS)	Maintenance Management System	On-Board Cameras	Scheduling Software	Vehicle Component Monitoring System	Driving Simulator
Sioux City Transit	✔	✔			✔	✔	✔	✔	E	✔		
MET Waterloo	✔	✔				✔	✔	E				
Keyline Dubuque	✔	✔				✔	✔	✔	✔			
Bettendorf Transit	***								***			
CitiBus Davenport	✔		✔			✔	✔	E	✔			✔
FST-Cedar Rapids		✔	✔	✔		✔	E	E	E	✔	✔	
Coralville Transit	✔		✔		✔		✔	✔	E			
Iowa City Transit	✔	✔		✔	✔	E	✔	✔	✔			
Cambus–U of Iowa	✔	✔	***		✔				E	✔		✔
CyRide - Ames	✔	✔	✔		✔	✔	✔	E	E			
DART–Des Moines	✔	✔		✔	✔	✔	✔	✔	✔	E		

*** Agency is planning on deploying that system in the near future.

Table 38. Summary of Recommended ITS Deployments by Phase and Agency

	Recommended Technology											
	CAD/AVL	APC	ATIS (web)	ATIS (itinerary planning)	ATIS (at stop)	Automatic Annunciation	Electronic Payment System (EPS)	Maintenance Management System	On-Board Cameras	Scheduling Software	Vehicle Component Monitoring System	Driving Simulator
Phase 1 (1-3 years)												
Sioux City Transit	✔	✔				✔	✔			✔		
MET Waterloo							✔					
Keyline - Dubuque	✔	✔				✔			✔			
Bettendorf Transit												
CitiBus - Davenport	✔					✔			✔			
FST-Cedar Rapids												
Coralville Transit	✔		✔									
Iowa City Transit	✔			✔								
Cambus – Univ. of Iowa	✔	✔								✔		
CyRide - Ames	✔	✔				✔						
DART – Des Moines	✔	✔						✔	✔			
Subtotal—Phase 1												
Phase 2 (3-5 years)					✔							
Sioux City Transit	✔	✔										
MET Waterloo							✔	✔				
Keyline - Dubuque												
Bettendorf Transit			✔				✔					✔
CitiBus - Davenport		✔	✔	✔		✔						
FST-Cedar Rapids					✔		✔					
Coralville Transit					✔		✔					
Iowa City Transit					✔							
Cambus – Univ. of Iowa			✔		✔		✔					
CyRide - Ames				✔	✔							
DART – Des Moines												
Subtotal—Phase 2								✔				
Phase 3 (Over 5 years)						✔						
Sioux City Transit												
MET Waterloo												
Keyline - Dubuque												
Bettendorf Transit												
CitiBus - Davenport								✔				
FST-Cedar Rapids		✔						✔	✔			
Coralville Transit												✔
Iowa City Transit												
Cambus – Univ. of Iowa						✔	✔					

Table 39. Summary of Technology Cost for All Large Urban Transit Systems

Agency	Recommended Technology											
	CAD/AVL	APC	ATIS (web)	ATIS (itinerary planning)	ATIS (at stop)	Automatic Annunciation	Electronic Payment System (EPS)	Maintenance Management System (MMIS)	On-Board Cameras	Scheduling Software	Driving Simulator	Total By Agency By Phase
Phase 1 (1-3 years)												
Sioux City	$703,000	$110,000				$255,000	$500,000			$150,000		$1,718,000
Waterloo							$340,000					$340,000
Dubuque	$418,000	$85,000				$190,000			$70,000			$763,000
Bettendorf												$0
Davenport	$483,000					$245,000			$50,000			$778,000
Cedar Rapids												$0
Coralville	$483,000		$81,000									$564,000
Iowa City	$563,000			$91,000								$654,000
Cambus	$563,000	$97,000								$150,000		$810,000
CyRide	$923,000	$135,000				$475,000						$1,533,000
DART	$1,160,000	$165,000						$520,000	$450,000			$2,295,000
Subtotal	***$5,296,000***	***$592,000***	***$81,000***	***$91,000***	***$0***	***$1,165,000***	***$840,000***	***$520,000***	***$570,000***	***$300,000***	***$0***	***$9,455,000***
Phase 2 (3-5 years)												
Sioux City					$125,000							$125,000
Waterloo	$458,000	$89,000										$547,000
Dubuque							$292,000	$215,000				$507,000
Bettendorf												$0
Davenport			$91,000				$430,000				$500,000	$1,021,000
Cedar Rapids		$85,000	$45,000	$45,000		$180,000						$355,000

Agency	Recommended Technology											
	CAD/AVL	APC	ATIS (web)	ATIS (itinerary planning)	ATIS (at stop)	Automatic Annunciation	Electronic Payment System (EPS)	Maintenance Management System (MMIS)	On-Board Cameras	Scheduling Software	Driving Simulator	Total By Agency By Phase
Coralville					$135,000		$275,000					$410,000
Iowa City					$100,000		$478,000					$578,000
Cambus					$125,000							$125,000
CyRide			$81,000		$135,000		$1,155,000					$1,371,000
DART				$101,000	$165,000							$266,000
Subtotal	***$458,000***	***$174,000***	***$217,000***	***$146,000***	***$785,000***	***$180,000***	***$2,630,000***	***$215,000***	***$0***	***$0***	***$500,000***	***$5,305,000***
Phase 3 (over 5 years)												
Sioux City								$265,000				$265,000
Waterloo						$205,000						$205,000
Dubuque												$0
Bettendorf												$0
Davenport												$0
Cedar Rapids												$0
Coralville								$215,000				$215,000
Iowa City		$97,000						$215,000	$150,000			$462,000
Cambus											$500,000	$500,000
CyRide												$0
DART						$745,000	$2,010,000					$2,755,000
Subtotal	***$0***	***$97,000***	***$0***	***$0***	***$0***	***$950,000***	***$2,010,000***	***$695,000***	***$150,000***	***$0***	***$500,000***	***$4,402,000***

Agency	Recommended Technology											
	CAD/AVL	APC	ATIS (web)	ATIS (itinerary planning)	ATIS (at stop)	Automatic Annunciation	Electronic Payment System (EPS)	Maintenance Management System (MMIS)	On-Board Cameras	Scheduling Software	Driving Simulator	Total By Agency By Phase
Grand Total	**$5,754,000**	**$863,000**	**$298,000**	**$237,000**	**$785,000**	**$2,295,000**	**$5,480,000**	**$1,430,000**	**$720,000**	**$300,000**	**$1,000,000**	**$19,162,000**

As mentioned in Section 5, it is evident that the Leased Wireless Mobile Data communications system option is the most reasonable for all agencies included in this study. It is a viable option because it provides state-of-the-art data communications systems, provides continuous upgrades and enhancements, has adequate coverage, and is the lowest in cost. Thus, it is recommended that the Leased Wireless Mobile Data option be exercised for the agencies included in this project. Table 40 provides a summary of the ITS technologies and expected capital costs of the Leased Wireless Mobile Data option.

Table 40. Summary of Total Cost of ITS Technologies and Leased Wireless Mobile Data

Phase/Agency	Recommended Technology		
	Cost of ITS Technologies	**Cost of Communications System**	**Total Cost**
Phase 1 (1-3 years)			
Sioux City	$1,718,000	$34,760	$1,752,760
Waterloo	$340,000	$23,700	$363,700
Dubuque	$763,000	$18,960	$781,960
Bettendorf	$0	$64,780	$64,780
Davenport	$778,000	$31,600	$809,600
Cedar Rapids	$0	0	$0
Coralville	$564,000	$17,380	$581,380
Iowa City	$654,000	$36,340	$690,340
Cambus	$810,000	$36,340	$846,340
CyRide	$1,533,000	$99,540	$1,632,540
DART	$2,295,000	$186,440	$2,481,440
Subtotal—Phase 1	***$9,455,000***	***$549,840***	***$10,004,840***
Phase 2 (3-5 years)			
Sioux City	$125,000	$0	$125,000
Waterloo	$547,000	$0	$547,000
Dubuque	$507,000	$0	$507,000
Bettendorf	$0	$0	$0
Davenport	$1,021,000	$0	$1,021,000
Cedar Rapids	$355,000	$0	$355,000
Coralville	$410,000	$0	$410,000
Iowa City	$578,000	$0	$578,000
Cambus	$125,000	$0	$125,000
CyRide	$1,371,000	$0	$1,371,000
DART	$266,000	$0	$266,000
Subtotal—Phase 2	***$5,305,000***	**$0**	***$5,305,000***
Phase 3 (Over 5 years)			
Sioux City	$265,000	$0	$265,000
Waterloo	$205,000	$0	$205,000
Dubuque	$0	$0	$0
Bettendorf	$0	$0	$0
Davenport	$0	$0	$0
Cedar Rapids	$0	$0	$0
Coralville	$215,000	$0	$215,000
Iowa City	$462,000	$0	$462,000
Cambus	$500,000	$0	$500,000
CyRide	$0	$0	$0
DART	$2,755,000	$0	$2,755,000
Subtotal—Phase 3	***$4,402,000***	**$0**	***$4,402,000***
Grand Total	**$19,162,000**	**$549,840**	**$19,711,840**

7. Funding Considerations

7.1 Background

Transit ITS projects are eligible for FTA funding through several programs. Typically in the transit industry ITS projects are funded through a combination of federal funding, state funding (where available) and local funding. FTA does not have any special funding programs specifically designed for technology deployment.

The Iowa Rural Transit ITS program has been funded through an FHWA grant (25%), state funding through the state's clean air program (CMAQ) (25%), and local funding. The program has received $250,000 annually through the state's ICAP program.

A specific funding program has not been developed for the Urban Transit ITS program at this point. The Urban Transit ITS Deployment Plan will be used to secure program funding.

This section presents a discussion of the potential funding sources that should be considered in funding the implementation of the Urban Transit ITS Deployment Plan. The listing of funding sources here does not constitute an ITS funding strategy for the urban transit systems in Iowa. Rather, it provides a list of potential funding sources that should be considered as Iowa DOT and local agencies pursues ITS funding. The sources presented here include the ITS funding sources from the Federal Transit Administration (FTA), the Federal Highway Administration (FHWA) and the U.S. Department of Transportation (USDOT).

The Federal ITS Research and Development Program is funded at $110 million per year through Federal Fiscal Year 2009. Of that amount, $7 million per year will go to the I-95 Corridor Coalition . The Road Weather Research and Development Program will receive $5 million. A study on Rural Interstate Communication Corridors is funded at $1 million in 2006 and $2 million in 2007. The rest of the funding is discretionary, subject to appropriations.

The Steering Committee is aware that funding for ITS projects is limited. The list of potential funding sources here is not intended to imply that federal ITS funding is plentiful, highly flexible, or easy to obtain, because that is not typically the case. There are many *potential* sources, including a number of traditional transportation funding sources where requirements have been relaxed over the last 10 years to allow ITS project funding. However, total funding levels are very modest, local and national competition is usually high, and many potential sources can only be used by very specific types of ITS projects (e.g., the FTA Job Access and Reverse Commute funds described below).

The information contained in this section was obtained from a variety of sources, including Maryland Department of Transportation, Office of Policy and Governmental Affairs, "SAFETEA-LU - Federal Surface Transportation Authorization FY2004 – FY2009: Section by Section Analysis, Impacts on Maryland," December 2005; various FTA and FHWA fact sheets; and other information obtained directly from the SAFETEA-LU legislation.

7.2 Definitions (SAFETEA-LU Section 3004)

While this is not a funding section of SAFETEA-LU, it is important to recognize that this section expands the current definition of “capital project” to include construction, renovation and improvement of intercity bus and intercity rail stations and terminals as an eligible capital project. Specific crime prevention and security activities are made eligible activities: refine and develop security and response plans; detect chemical and biological agents in transit; conduct emergency response drills with transit agencies and first responder agencies; and, security training for transit employees.

7.2.1 Surface Transportation Program (STP) (SAFETEA-LU Section 1113)

STP provides flexible funding that may be used by States and localities for projects on any Federal-aid highway, including the National Highway System (NHS), bridge projects on any public road, **transit capital projects, and public bus terminals and facilities**. SAFETEA-LU expands STP eligibility. The Federal share is generally 80 percent. When the funds are used for Interstate projects to add high occupancy vehicle or auxiliary lanes, but not other lanes, the Federal share may be 90 percent. Certain safety improvements listed in 23 USC 120(c) have a Federal share of 100 percent. The set-aside of 10 percent previously required for safety construction activities (i.e., hazard elimination and rail-highway crossing improvements) is eliminated beginning in 2006, as these activities are funded separately under the new Highway Safety Improvement Program. The 10 percent set-aside for Transportation/enhancement Activities continues.

7.2.2 Transportation, Community, and System Preservation Program (TCSP) (SAFETEA-LU Section 1117)

$270 million in discretionary funds nationwide is provided through 2009, to carry out eligible projects to integrate transportation, community, and system preservation plans and practices. The federal share for projects is 80%.

7.2.3 Real-Time System Management Information Program (SAFETEA-LU Section 1201)

The purposes of this program are to:

- Establish, in all States, a system of basic real-time information for managing and operation the surface transportation system;
- Identify longer range real-time highway and transit monitoring needs and develop plans and strategies for meeting the needs; and
- Provide the capability and means to share the data with State and local governments, and the traveling public.

No separate funds are authorized for this program. States may use their NHS, Congestion Mitigation and Air Quality (CMAQ) Improvement program, and STP apportionments for activities related to the **planning and deployment of real-time monitoring elements** that advance the goals of the program to the extent that such activities are eligible for funding under the source program.

Within two years of the date of enactment of SAFETEA-LU, data exchange formats will be established to ensure that the data provided by highway and **transit monitoring systems** can be readily exchanged to facilitate nationwide availability of information. As States and local governments develop or update regional ITS architectures as described in 23 CFR 940.9, they shall explicitly address real-time highway and **transit information needs**, and the systems needed to meet those needs. The term "statewide incident reporting system" is defined as a statewide system for facilitating the real-time electronic reporting of surface transportation incidents to a central location for use in monitoring the event, providing accurate traveler information, and responding to the incident as appropriate.

7.2.4 State Infrastructure Banks (SIB) (SAFETEA-LU Section 1602)

SIBs provide various forms of nongrant assistance to public or private entities for eligible projects, including below-market rate subordinate loans, subsidize interest rates, and guarantees and other forms of credit enhancement. This provision expands the SIB program to all of the States and expands the eligible assistance that can be obtained by using a SIB. The new program also permits multiple states to form a SIB.

7.2.5 Congestion Mitigation and Air Quality Improvement (CMAQ) (SAFETEA-LU Section 1808)

The CMAQ program provides a flexible funding source to State and local governments for transportation projects and programs to help meet the requirements of the Clean Air Act. The Federal share is generally 80 percent, subject to sliding scale and 90 percent for Interstate projects. Certain other activities, including carpool/vanpool projects, priority control systems for emergency vehicles and transit vehicles and traffic control signalization receive a Federal share of 100 percent.

7.2.6 Research, development, demonstration, and deployment projects (SAFETEA-LU Section 3014)

This section provides for federal grants and agreements for research of technology of national significance for public transportation.

7.2.7 National research and technology programs (SAFETEA-LU Section 3016)

This section requires the Secretary of USDOT to continue to make funds available to help **public transportation providers comply with the Americans with Disabilities Act of 1990**, including establishment of a National Technical Assistance Center for Senior Transportation, and a medical transportation demonstration grants program. It also provides $3 million annually in grants and demonstration grants for medical and senior transportation purposes. Eligible services are non-emergency medical visits serving those elderly and disabled persons needing dialysis and other treatments linked with renal disease.

7.2.8 Job Access and Reverse Commute Formula Grants (SAFETEA-LU Section 3018/49 USC 5316)

The Job Access and Reverse Commute Formula Grant (JARC) program provides transportation to and from employment for persons with low income. The old program has been converted from a discretionary grant program to a formula program. In addition to services currently eligible, the **program would allow for reimbursement of transportation service**

maintenance, planning and capital costs. The formula is weighted to states with large populations of low-income individuals and welfare recipients in urban areas. Generally, the monies directed to urbanized areas must serve the population in those areas. States must undertake statewide solicitation for applications for JARC competitive grants to recipients and subrecipients.

7.2.9 New Freedom Program (SAFETEA-LU Section 3019/49 USC 5317)

This program establishes a new New Freedom initiative, which provides formula funding for new **public transportation services and public transportation alternatives beyond those required by the ADA** (Americans with Disabilities Act). Federal share is 80 % for capital projects, 50% for operating expenses. It will assist individuals with disabilities, including transportation to and from employment and support services.

7.2.10 Metropolitan and Statewide Planning Programs (49 USC 5305, 5304 and 5305)

This Program, now consolidated under SAFETEA-LU, establishes a cooperative, continuous, and comprehensive framework for making transportation investment decisions in metropolitan areas and statewide. Eligible recipients are State DOTs and Metropolitan Planning Organizations. Eligible purposes are those that support the economic vitality of theses areas, especially by enabling global competitiveness, productivity, and efficiency; **increase the safety and security of the transportation system** for motorized and non-motorized users; **increase the accessibility and mobility options available to people** and for freight; protect and enhance the environment, promote energy conservation, and improve quality of life; **enhance the integration and connectivity of the transportation system**, across and between modes, for people and freight; **promote efficient system management and operation**; and emphasize the preservation of the existing transportation system.

7.2.11 Urbanized Area Formula Program (49 USC 5307)

This Program provides grants for Urbanized Areas for **public transportation capital investments** (and operating expenses in areas under 200,000 population) from the Mass Transit Account of the Highway Trust Fund. The basic formula (using population, population density, and level of transit service) is augmented by two new formula features:

- New Small Transit Intensive Cities formula for urbanized areas under 200,000 that provide more service per capital than do other comparable areas; and
- New Growing States and High Density States formula.

The Program requirements are generally unchanged from TEA-21.

7.2.12 Bus and Bus Facility Grants (49 USC 5309 and 5318)

The purpose of this Program is to provide funding for the acquisition of buses for fleet/service expansion, and **bus related facilities** such as maintenance facilities, transfer facilities, terminals, **computers**, garage equipment, bus rebuilds, and passenger shelters. ITS could be considered as part of the bus related facilities portion of the Program. See

7.2.13 Human Services Transportation Coordination (SAFETEA-LU Section 3046/ 49 U.S.C. Sections 5302, 5303, 5310, 5311, 5314, 5316, and 5317)

The purpose of this Program is to improve transportation services for persons with disabilities, older adults, and individuals with lower incomes by ensuring that **communities coordinate transportation resources** provided through multiple federal programs. **Coordination will enhance transportation access, minimize duplication of services, and facilitate the most appropriate cost-effective transportation possible with available resources**. The most relevant portion of this program to Iowa DOT at this point is the **Mobility Management aspect**, which is an eligible Federal capital expense supported with 80% Federal public transportation funding. Mobility management consists of short-range planning and management activities and projects for improving coordination among public transportation and other transportation service providers. It includes personnel and technology activities. Mobility Management funding may not be applied to operating public transportation services. This Program permits funding from other non-DOT programs to be used to meet matching funds requirements for transportation services under Sections 5310, 5316, 5317 programs and the Section 5311 non-urbanized area formula program. Section 5310 and Section 5311 funds may also be matched by funds from the Federal Lands Highway Program established by Section 204 of title 23.

7.2.14 Other Sources

Iowa Homeland Security and Emergency Management received over $22 million in grants in FY 2005, over $14 million of which was for the Homeland Security Grant Program. In terms of total grants, Iowa received less than 1 percent of the funding granted to all states and US territories. Even though this funding level is fairly low, it is important to work with Iowa Homeland Security and Emergency Management to determine if portions of the Urban Transit ITS Deployment would be eligible for US Department of Homeland Security funding. For example, if a key feature of a CAD/AVL system is a silent alarm/covert microphone, it is possible that the deployment of this system could be funded, in part, by Homeland Security funding.

7.3 Conclusions on Program Funding

Although a specific funding program has not been established, there are several important conclusions that must be considered as part of the funding program.

- It is likely that most of the transit will be unable to implement the recommended ITS technologies without 80 percent funding from non-local sources. Even 50 percent funding from external sources is probably insufficient for most agencies.
- A goal of securing 80 percent funding from federal sources should be established. This may be accomplished through a mix of funding programs. Available sources at the federal level are listed previously in this section.
- It is acknowledged that traditional federal funding sources such as 5309 discretionary funding is limited and other needs, such as bus replacement, will likely be a higher priority.
- The state is supportive of the Urban Transit ITS Deployment Plan project and will contribute funding as the state is able to identify available funding. It is acknowledged that state funding for transportation projects is limited, and very competitive.
- Because of transit's important role in Homeland Security – related strategies security related funding should be pursued.

8. Organizational and Technical Impacts

Another important area that must be assessed before selecting and deploying any ITS technology is the impact that each technology will have on the agency and its personnel. Before deployment, transit agencies must be aware of how the new technologies will impact them both organizationally and technically. Some transit ITS technologies may require an agency to augment, reallocate, or reduce its staff. In addition, some of the new technologies will impact the way transit staff performs certain tasks and hence will require new procedures to be established.

Table 41 displays various organizational and technical impacts that will affect Iowa's large urban transit systems as a result of implementing the recommended technologies. The table also lists the recommended actions required to mitigate these impacts.

(on next page)

Table 41. Organizational and Technical Impacts

Technology	ORGANIZATIONAL		TECHNICAL	
	Impact	Recommended Actions	Impact	Recommended Actions
CAD/AVL (including MDT and silent alarm)	Availability of on-time (performance) data	Planning and scheduling staff need to train on how to make use of available data	Real-time location	Dispatchers need to get used to making quick decisions based on real-time information
		Procedures need to be established on how/when to get needed data	CAD provides group talks (calling one vehicle, vehicles by route, or all vehicles)	Dispatchers will need to use this feature efficiently.
		Scheduling/Planning may need to modify how schedules and routes are modified based on new data that is readily available and is more comprehensive.	Some dispatchers may not have typing skills	To type and send text messages, dispatcher need to get training on basic typing skills
	Not logging in at right location (e.g. at end of route) may cause discrepancies in data	Procedures on logging in and off must be established and strictly followed	Some dispatchers may not have background in using PC	Training on using Windows
	Drivers tend, out of habit, to continue using radio instead of MDT even when it is not necessary	Drivers need to be trained on using MDT during before installation in order to get them comfortable using the new equipment. This will reduce voice traffic.	Handling of transfer requests	Drivers need to be trained on how to deal with transfer requests and to accommodate such requests
	Dispatchers may not know what actions to take when silent alarm is activated	Procedures for dealing with silent alarm activation need to established and followed by the dispatchers.		
	Drivers may misuse silent alarm	Drivers need to follow procedures of when to use the silent alarm		
	Neither street supervisors nor checkers need to perform on-time performance checks	Number of checkers may need to be reduced and street supervisors' time may need to be re-allocated for other tasks.		
Maintenance Management System	Planning will need access to maintenance records	Procedures will need to be established on how, when, and by whom records can be accessed	Lack of knowledge in using the new software	Training of maintenance staff on software
	Maintenance records need	Procedures for the contractors need to		

Technology	ORGANIZATIONAL		TECHNICAL	
	Impact	**Recommended Actions**	**Impact**	**Recommended Actions**
	to be kept up-to-date	be established on prompt completion of all maintenance records.		
Advanced Traveler Information Systems (Annunciator, real-time arrival, Web information, etc..)	Information updates	Agency should establish which department is responsible for maintaining the information	Additional onboard and wayside equipment to be maintained	Staff will need to be trained on maintaining this equipment
	Solicitation of advertisement	If advertisements are to be displayed on systems (e.g. on DMSs), staff may need to be augmented to pursue this	Availability of power for signs	Locations such as bus stops may not have readily available power supply for the DMSs. Provision of power and/or phone line need to be coordinated within the agency and other agencies.
		Guidelines for accepting/displaying advertisement need to be established by legal department		
APC	Availability of accurate and reliable ridership data	Procedures need to be established on how/when to get needed data	Passenger Information Support may not be familiar with new system	Planning and scheduling staff need to train on how to make use of available data
		Scheduling/Planning may need to modify how schedules and routes are modified based on new data that is readily available and is more comprehensive.		Passenger Information Support will need to train on the new system
	Checkers need not perform ridership counts	Number of checkers may need to be reduced	Maintenance issues	Maintenance staff need to be trained on new equipment
In-Vehicle Surveillance Cameras	Privacy issues	Procedures need to be set regarding who can review images.	Maintenance issues	Maintenance staff need to be trained on cameras
		Guidelines on when (under what circumstances) and with whom can images data be shared (e.g. police) need to be developed		

9. Implementation 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 the same ITS hardware and software is appropriate for multiple agencies.

Based on the work that was accomplished in this project, and experience from other projects, there is strong evidence that some economies of scale can be gained by procuring some 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 especially with regard to communications infrastructure and CAD/AVL systems;
- Selecting funding sources that allow flexibility;
- Leveraging intellectual property rights;
- 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 Iowa DOT transit staff to develop procurement expertise when dealing with ITS, they may want to consider outside help from a consultant with ITS procurement expertise.

9.1 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.

The last item, sole source procurement, is usually not appropriate for procurements of this type because of their size and complexity. However, if the agency is exploring public/private partnerships, as may be the case with communications systems, 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. 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. 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.

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. 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.

9.2 Procurement Recommendations

TranSystems strongly recommends that an RFP process be used for the majority of transit ITS procurements for the urban transit systems in 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 be used for some data communications equipment. However, if MDTs are being purchased and must interface with scheduling and dispatching software, they should be part of the software procurement. 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).

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

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

- 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);
- Whether or not a contractual vehicle is set up at the regional level to allow agencies within a DOT region to purchase their ITS systems; 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 large urban 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.

Another option is for several agencies with similar objectives to team up to procure specific ITS system or systems. This will require establishing a contractual vehicle at the region level that will allow the agencies to purchase their transit ITS systems.

Setting up a statewide or regional 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[2] 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 State-wide 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.

Based on the above discussion and the distribution of ITS technologies in

[2] "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

Table 38, it seems reasonable to adopt all three different approaches of deployment strategies: state-wide contractual vehicle, regional contractual vehicle and individual agency RFPs.

Table 38 shows that almost all agencies included in this project are going to deploy CAD/AVL systems (with the exception of Cedar Rapids). Thus, a CAD/AVL procurement may be a good candidate for a state-wide contract. Over 325 vehicles are to be equipped with AVL components, (e.g. GPS antennas, MDTS), which means that there is an opportunity for cost savings based on economies of scale. Given that the majority of MDT procurement involves in-vehicle hardware and software, procurement of 325 units versus as many as 30 at a time will potentially yield lower cost units. Although Waterloo's CAD/AVL system is planned as a Phase 2 deployment, this deployment may be moved to Phase 1 in order to take advantage of the state-wide procurement.

As mentioned earlier in the report, it makes good sense to deploy certain technologies at the same time as deploying a CAD/AVL system. Hence, it is recommended that APC, ATIS and automatic annunciation systems included in Phase 1 be made part of the state-wide procurement of CAD/AVL systems (along with Waterloo's APC system planned for Phase 2).

As mentioned earlier, a case can be made for a regional contractual vehicle especially during Phase 2 deployments. For example, there is a relatively large number of deployments in Regions 10 and 11. Hence, agencies in these regions may want to set up a contractual vehicle to procure these technologies as a collective.

Projects not included in either of the state-wide or regional procurement efforts, as discussed in the previous paragraphs, may be procured through RFPs issued by individual agencies.

Table 42 identifies the recommended technology within each of the three procurement strategies discussed above. (S = State-wide contract, R10 = Regional contract for Region 10, R11 = Regional contract for Region 11 and A = Agency issued RFP).

(on next page)

Table 42. Recommended ITS Technologies by Procurement Strategy

Phase	Agency	Recommended Technology											
		CAD/AVL	APC	ATIS (web)	ATIS (itinerary planning)	ATIS (at stop)	Automatic Annunciation	Electronic Payment System (EPS)	Maintenance Management System	On-Board Cameras	Scheduling Software	Vehicle Component Monitoring System	Driving Simulator
Phase 1 (1-3 years)													
Region 4	Sioux City	**S**	**S**				**S**	**A**			**A**		
Region 7	MET							**A**					
Region 8	Keyline	**S**	**S**				**S**			**A**			
Region 9	Bettendorf												
	CitiBus	**S**					**S**			**A**			
Region 10	FST												
	Coralville	**S**		**S**									
	Iowa City	**S**			**S**								
	Cambus	**S**	**S**								**A**		
Region 11	CyRide	**S**	**S**				**S**						
	DART	**S**	**S**						**A**	**A**			
Phase 2 (3-5 years)													
Region 4	Sioux City					**A**							
Region 7	MET	**S**	**S**										
Region 8	Keyline							**A**	**A**				
Region 9	Bettendorf												
	CitiBus			**A**				**A**					**A**
Region 10	FST		**R10**	**R10**	**R10**		**R10**						
	Coralville					**R10**		**R10**					
	Iowa City					**R10**		**R10**					
	Cambus					**R10**							
Region 11	CyRide			**R11**		**R11**		**R11**					
	DART				**R11**	**R11**							
Phase 3 (over 5 years)													
Region 4	Sioux City								**A**				
Region 7	MET						**A**						
Region 8	Keyline												
Region 9	Bettendorf												
	CitiBus												
Region 10	FST												
	Coralville								**A**				
	Iowa City		**A**						**A**	**A**			
	Cambus												**A**
Region 11	CyRide												
	DART						**A**	**A**					

10. National ITS Architecture

Given that the ultimate objective of this project is to develop a deployment plan for implementing ITS technologies for the large urban transit systems in Iowa, the introduction of basic concepts of the National ITS Architecture such as User Services and Market Packages may be helpful in getting to understand the relationship between ITS architecture and transit ITS deployments.

The National ITS Architecture provides a common framework for planning, defining, and integrating intelligent transportation systems. Hence, the National ITS Architecture is not a design tool, rather it defines the framework around which different approaches to design and implement systems could be developed.
The architecture defines:

- The functions (e.g., gather traffic information or request a route) that are required for ITS.
- The physical entities or subsystems where these functions reside (e.g., the roadside or the vehicle).
- The information flows that connect these functions and physical subsystems into an integrated system.

The ITS architecture helps guide transportation professionals in developing standards and making deployment decisions that will result in efficiency, economies of scale, and national interoperability. Through the adoption of the National ITS Architecture when implementing projects, agencies can be assured that their systems will easily interface with other products and systems. Equally important, is the fact that the National Architecture provides a common ground for a region's various agencies to integrate their ITS systems and to be able to coordinate at the regional level.

10.1 User Services

User Services document what ITS should do from the user's perspective. A broad range of users are considered, including the traveling public as well as many different types of system operators. Thirty-two User Services form the basis for the National ITS Architecture development effort. These User Services were jointly defined by USDOT and ITS America with significant stakeholder input. The concept of User Services allows system or project definition to begin by establishing the high level services that will be provided to address identified problems and needs. New or updated User Services may be added to the National ITS Architecture over time.

In Table 43 User Services are grouped into logical bundles to provide a convenient way to discuss the range of requirements in a broad stakeholder area. User Services are grouped into the following eight bundles: Travel and Traffic Management, Public Transportation Management, Electronic Payment, Commercial Vehicle Operations, Emergency Management, Advanced Vehicle Safety Systems, Information Management, and Maintenance and Construction Operations.

(on next page)

Table 43. User Services and Bundles

User Service Bundle	User Services
1 Travel and Traffic Management	1.1 Pre-trip Travel Information 1.2 En-route Driver Information 1.3 Route Guidance 1.4 Ride Matching and Reservation 1.5 Traveler Services Information 1.6 Traffic Control 1.7 Incident Management 1.8 Travel Demand Management 1.9 Emissions Testing and Mitigation 1.10 Highway-rail Intersection
2 Public Transportation Management	2.1 Public Transportation Management 2.2 En-route Transit Information 2.3 Personalized Public Transit 2.4 Public Travel Security
3 Electronic Payment	3.1 Electronic Payment Services
4 Commercial Vehicle Operations	4.1 Commercial Vehicle Electronic Clearance 4.2 Automated Roadside Safety Inspection 4.3 On-board Safety Monitoring 4.4 Commercial Vehicle Administrative Processes 4.5 Hazardous Material Incident Response 4.6 Commercial Fleet Management
5 Emergency Management	5.1 Emergency Notification and Personal Security 5.2 Emergency Vehicle Management
6 Advanced Vehicle Safety Systems	6.1 Longitudinal Collision Avoidance 6.2 Lateral Collision Avoidance 6.3 Intersection Collision Avoidance 6.4 Vision Enhancement for Crash Avoidance 6.5 Safety Readiness 6.6 Pre-Crash Restraint Deployment 6.7 Automated Vehicle Operation
7 Information Management	7.1 Archived Data Function
8 Maintenance and Construction Management	8.1 Maintenance and Construction Operations

Table 44 summarizes the User Services identified for the various technologies under consideration for deployment.

(on the next page)

Table 44. Mapping Transit ITS Technologies to User Services

	Travel and Traffic Management				Public Transportation Management				Electronic Payment	Advanced Vehicle Safety Systems			Infor-mation Mgmt
	1.1	1.3	1.5	1.6	2.1	2.2	2.3	2.4	3.1	6.1	6.2	6.3	7.1
Communications Systems	✔	✔	✔	✔	✔	✔		✔	✔				✔
Automatic Vehicle Location Systems		✔			✔		✔	✔					✔
Automatic Passenger Counters					✔								✔
Vehicle Monitoring Systems					✔								✔
Fixed-Route Scheduling Software					✔		✔						✔
Electronic Fare Payment Systems					✔				✔				✔
Pre-Trip Transit Information Systems	✔	✔	✔				✔						✔
In-Terminal Information Systems	✔	✔	✔			✔							✔
In-Vehicle Information Systems						✔							✔
On-Vehicle Surveillance								✔					✔
Maintenance Management System					✔								✔

The following are definitions of User Services as identified in the ITS National Architecture:

1.1 **Pre-Trip Travel Information:** Assists travelers in making mode choices, travel time estimates, and route decisions prior to trip departure.

1.3 **Route Guidance:** Provides demand responsive drivers with directions to selected destinations.

1.5 **Traveler Services Information:** Provides travelers with service and facility data for the purpose of assisting prior to embarking on a trip or after the traveler is underway. The functions which are included in this capability are Information Receipt and Information Access providing travelers with a "yellow pages" type of capability.

1.6 **Traffic Control:** Provides the capability to efficiently manage the movement of traffic on streets and highways. It will also permit transit, safety and emergency vehicles to have preference over other vehicles being controlled.

2.1 **Public Transportation Management:** Provides functions such as collection of information about the vehicle location, schedule adherence, vehicle passenger loading, fare collection by fare category, and schedule deviations. It allows automation of planning and scheduling activities, making requests for signal priority, and collection of information about passenger use of the transit services.

2.2 **En-Route Transit Information:** Provides travelers with real-time transit and high-occupancy vehicle information allowing travel alternatives to be chosen once the traveler is en-route. It consists of three major functions which are (1) Information Distribution, (2) Information Receipt, and (3) Information Processing.

2.3 **Personalized Public Transit:** Functions as a “travel agent” for various modes of transit, including personalized transit. The Transit Management Subsystem computes the logistics for individual requests and communicates the personalized schedules to travelers.

2.4 **Public Travel Security:** Provides surveillance of transit vehicles and facilities (bus stop areas, Park and Ride areas, and transit transfer locations) and identifies potentially hazardous situations and notifies the appropriate response agencies.

3.1 **Electronic Payment Services:** This allows travelers to pay for transportation services by electronic means. Four functions are provided which are (1) Electronic Toll Collection, (2) Electronic Fare Collection, (3) Electronic Parking Payment, and (4) Electronic Payment Services Integration.

6.1 **Longitudinal Collision Avoidance:** Includes a Rear-End Subservice to assist in maintaining a safe relative longitudinal separation between vehicles, and will also include a Backing Subservice that will notify the driver of the presence of potentially hazardous situations.

6.2 **Lateral Collision Avoidance:** Similar to Longitudinal Collision Avoidance except that it deals with merging and lane changes.

6.3 **Intersection Collision Avoidance:** Includes an advisory system that notifies the driver of the presence of potentially hazardous situations.

7.1 **Archived Data:** Provides the Historical Data Archive Repositories and controls the archiving functionality for all ITS data.

10.2 Market Packages

Some of the 32 User Services are too broad in scope to be useful in planning actual deployments. Additionally, they often do not translate easily into existing institutional environments and do not distinguish between major levels of functionality. In order to address these concerns (in the context of providing a more meaningful evaluation), a finer grained set of deployment-oriented ITS service building blocks were defined from the original user services. These are called "Market Packages" in the documentation.

Market Packages are defined by sets of equipment packages required to work together (typically across different subsystems) to deliver a given transportation service and the major architecture flows between them and other important external systems. *In other words, they identify the pieces of the National ITS Architecture required to implement a service.* As such, they are directly grounded in the definition of the Architecture. Most Market Packages are made up of equipment packages in two or more subsystems. Market Packages are designed to address specific transportation problems and needs and can be related back to the 32 User Services and their more detailed requirements. For example, the functionality of the broad User Service named "traffic control" was broken up into several Market Packages to allow for explicit consideration of:

- Basic functions (such as surveillance, which is represented by the "network surveillance" and "probe surveillance" market packages),
- Institutional settings (by separating control functions typically performed by different agencies into the "surface street control" and "freeway control" market packages), and
- Functional levels of service (by including a "regional traffic control" market package that provides for coordination of control strategies across jurisdictions).

In addition, a “Multimodal Coordination” Market Package was defined that is comprised of functionality for transit vehicle priority treatment at traffic signals. The "Emergency Routing" Market Package includes the functionality for emergency vehicle preemption at traffic signals.

The National ITS Architecture development effort identified a total of 75 Market Packages that reflect the current definition of ITS and the evolving technology market. Market Packages are not intended to be tied to specific technologies, but depend on the current technology and product market in order to be implemented. As transportation needs evolve, technology advances, and new devices are developed, market packages may change and new market packages may be defined. Figure 3 illustrates a sample Market Package.

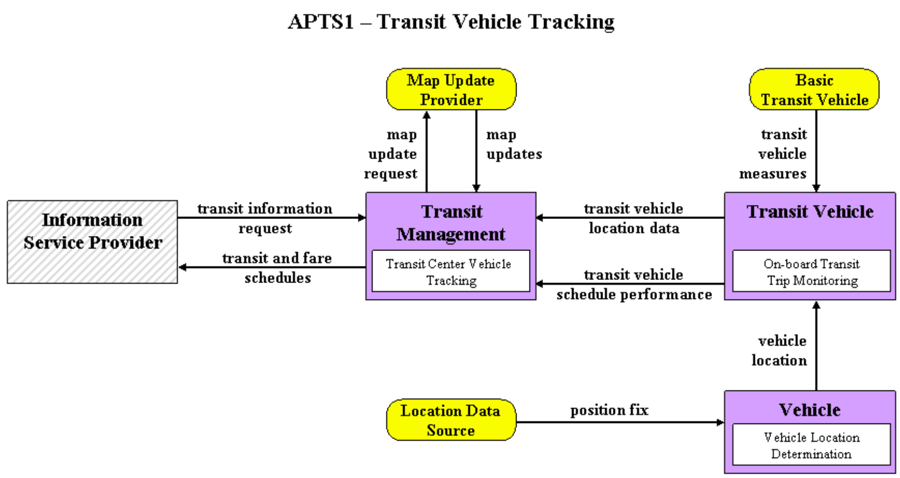

Figure 3. Transit Vehicle Tracking Package Graphic

The following are definitions of Market Packages as identified in the ITS National Architecture:

APTS1 **Transit Vehicle Tracking:** Monitors current transit vehicle location using an AVL system. The location data may be used to determine real-time schedule adherence and update the transit system's schedule in real-time.

APTS2 **Transit Fixed Route Operations:** Performs vehicle routing and scheduling, as well as automatic driver assignment and system monitoring for fixed route transit services. This service determines current schedule performance using AVL data and provides information displays at the Transit Management Subsystem.

APTS3 **Demand Response Transit Operations:** Performs vehicle routing and scheduling as well as automatic driver assignment and monitoring for demand responsive transit services.

APTS4 **Transit Passenger and Fare Management:** Manages passenger loading and fare payments on-board vehicles using electronic means.

APTS5 **Transit Security:** Provides for the physical security of transit passengers. An on-board security system performs surveillance and warns of potentially hazardous situations. Public areas (e.g. stops, park and ride lots, stations) are also monitored.

APTS6 **Transit Maintenance:** Supports automatic transit maintenance scheduling and monitoring. On-board condition sensors monitor system status and transmit critical status information to the Transit Management Subsystem.

APTS7 **Multi-Modal Coordination:** Establishes two-way communications between multiple transit and traffic agencies to improve service coordination, operating efficiency, and on-time performance.

APTS8 Transit Traveler Information: Provides transit users at transit stops and on-board transit vehicles with ready access to transit information. The information services include transit stop annunciation, imminent arrival signs, and real-time transit schedule displays.

ATIS1 Broadcast Traveler Information: Collects traffic conditions, advisories, general public transportation, toll and parking information, incident information and weather information, and broadly disseminates this information through existing infrastructures and low cost user equipment.

ATIS2 Interactive Traveler Information: Provides tailored information (transit, traffic, parking, etc.) in response to a traveler request. Both real-time interactive request/response systems and information systems that "push" a tailored stream of information to the traveler based on a submitted profile are supported.

ATMS7 Regional Traffic Control: Provides for the sharing of traffic information and control among traffic management centers to support a regional control strategy.

ATMS8 Incident Management System: Manages both unexpected incidents and planned events so that the impact to the transportation network and traveler safety is minimized. The market package includes incident detection capabilities through roadside surveillance devices (e.g. CCTV) and through regional coordination with other traffic management, maintenance and construction management and emergency management centers.

AVSS01 Vehicle Safety Monitoring: This market package will diagnose critical components of the vehicle and warn the driver of potential dangers. On-board sensors will determine the vehicle's condition and performance while also determining on-board safety data and display information.

AVSS03 Longitudinal Safety Warning: Allows for longitudinal warning. It utilizes safety sensors and collision sensors. It requires on-board sensors to monitor the areas in front of and behind the vehicle and present warnings to the driver about potential hazards.

AVSS04 Lateral Safety Warning: Allows for lateral warning. It utilizes safety sensors and collision sensors. It requires on-board sensors to monitor the areas to the sides of the vehicle and present warnings to the driver about potential hazards.

AVSS05 Intersection Safety Warning: Determines the probability of a collision in an equipped intersection (either highway-highway or highway-rail) and provides timely warnings to drivers in response to hazardous conditions. Monitors in the roadway infrastructure assess vehicle locations and speeds near an intersection.

Table 45. Mapping Transit ITS Technologies to Market Packages

	Public Transportation								Traffic Management		Vehicle Safety				Traveler Information	
	APTS 1	APTS 2	APTS 3	APTS 4	APTS 5	APTS 6	APTS 7	APTS 8	ATMS 7	ATMS 8	AVSS 1	AVSS 3	AVSS 4	AVSS 5	ATIS 1	ATIS 2
Communications Systems	✓	✓	✓		✓	✓	✓									
Automatic Vehicle Location Systems	✓	✓	✓		✓	✓	✓			✓						
Automatic Passenger Counters				✓												
Vehicle Monitoring Systems						✓					✓					
Scheduling Software (Fixed route)		✓														
Electronic Fare Payment Systems				✓												
Pre-Trip Transit Information Systems		✓					✓			✓					✓	✓
In-Terminal Information Systems		✓						✓							✓	✓
In-Vehicle Information Systems		✓						✓								
On-Vehicle Surveillance					✓											
Maintenance Management System						✓										

11. Recommendations and Next Steps

The conclusion of the Urban Transit ITS Deployment Plan is that ITS applications can be beneficial to the state's transit systems and transit agency managers have a high level of interest in these technology tools.

It is recommended that the urban transit agencies, working with Iowa DOT OPT and in the context of the Steering Committee pursue implementation of the recommendations included in the Deployment Plan report.

A key first step is securing funding for the projects. A funding plan must be developed.

The approach used successfully for the Rural Transit ITS Deployment Plan was to prepared individual, more detailed, technology plans for each participating transit agency. These Agency Technology Plans allowed agency mangers to focus on implementation and developing the funding approach necessary.

It is recommended that urban transit agencies deciding to move forward begin the preparation of an Agency Technology Plan.

The Urban Transit ITS Deployment Plan document should be used as a road map to help large urban transit systems in Iowa deploy ITS technologies using a logical and phased approach. The Deployment Plan can be considered an intermediate phase that builds on the Needs Assessment, while setting the stage for the procurement of the recommended ITS technologies. Beyond the Deployment Plan, the following four steps will need to be taken before ITS systems are fully operational:

1. **Develop Funding Plan**

   The funding plan should identify sources of funding for the associated capital and ongoing operating and maintenance costs of technology deployment.

2. **Development of Specifications:**

   a. **Prepare Functional Requirements.** The functional requirements for ITS technologies must be developed. A functional requirement indicates what capability the system is required to achieve rather than identifying specifically how that capability should be provided. An example of a functional requirement would be to require that the system frequently update the current location of each vehicle on a map display using a symbol that indicates at least the route, direction and schedule adherence status. Functional requirements are often combined with associated performance requirements. In the case of the above requirement, an associated performance requirement might be that the location for each vehicle be updated at least once per minute.

   b. **Determine Architecture Consistency.** The Federal Transit Administration (FTA) National ITS Architecture Policy on Transit Projects requires that ITS projects that are funded wholly or in part by Federal funding conform to certain requirements. The final design must be based on the required Systems Engineering Analysis (SEA) process. Developing specifications based on an assessment of operational and organizational needs is consistent with the initial portion of the required SEA.

c. **Prepare Functional Specifications.** The functional specifications should be traceable directly back to the functional requirements. The functional requirements should translate, together with the associated performance and quality requirements, and any integration requirements/ constraints, into a set of structured specifications. This involves writing the requirements as plain language sentences and organizing the requirements into functional subsystems. Further, functional specifications should become the basis of acceptance testing once the system is initially deployed.

   In addition to system and subsystem functional specifications, additional sections will address the other types of requirements essential to successful implementation and operation, including installation, testing, documentation, training and maintenance/warranty.

3. **Procurement of ITS Technologies:** This will include the following steps:

- **Develop and issue a Request for Proposals** (RFP) that includes the functional specifications
- **Conduct a Pre-Proposal Meeting**
- **Receive and Evaluate Proposals**
- **Interview Short-listed Proposers** (if desired)
- **Issue a request for Best and Final Offers** (BAFO) (if needed)
    - o **Make Final Vendor Selection**
    - o **Negotiate and Award Contract**

4. **Implementation of Procured ITS Technologies:** This phase follows the procurement and results in the full deployment of the technologies.

APPENDIX A

Iowa Department of Transportation

Intelligent Transportation Systems Deployment Plan:
Large Urban Systems

Transit Components of Iowa ITS Statewide Architecture and Related Local ITS Projects

September 18, 2006

Prepared by:

SNYDER & ASSOCIATES

In association with:

TranSystems

Iowa's *Statewide Transit Intelligent Transportation Systems Deployment Plan* includes an inventory of statewide ITS resources (*Working Paper 6: Inventory of Statewide ITS Resources*). This memo will detail ITS transit resources by metropolitan area per the DOT inventory in *Working Paper 6,* either by planned projects or projects already in operation (projects noted in *Working Paper 6* are noted as "*Statewide ITS Transit Projects*"). Other known ITS projects or possible opportunities for ITS transit project coordination in the metropolitan areas will be added to this memo (noted as "Other Related ITS Information").

Overall Statewide ITS Projects (no specific metropolitan area):

In Operation:

- Transit Agency Schedules: Link to other bus schedules/information on the Internet

Ames:

Statewide ITS Transit Projects in Operation:

- Ames Online Route Information

Other Related ITS Information:

- City of Ames uses the MARC NX traffic management system
- Copper twisted pair communication system traditionally

Cedar Falls/Waterloo:

Statewide ITS Transit Projects in Operation:

- Waterloo CAD (computer aided dispatch systems)

Other Related ITS Information:

- Cedar Falls Utilities has a fiber optic system used for cable TV and other communications.
- Waterloo has twisted pair closed loop signal systems. The City also has a wireless backbone system. Many signals have video detection, with the video detection data transferred to City communications center.

Cedar Rapids:

Statewide ITS Transit Projects in Operation:

- Cedar Rapids CAD/AVL: Automatic vehicle location and computer-aided dispatch systems
- Cedar Rapids On-Board Surveillance: On-board surveillance of transit vehicles

Other Related ITS Information:

- Cedar Rapids uses the ACTRA traffic management system, with interconnected signals via a mix of fiber optic and copper wire communication. Cedar Rapids also has additional signal preemption. Two intersections in the city have video detection cameras, whose detection data (intersection observation data) is routed back to the Engineering offices.
- Cedar Rapids is currently letting a large communications project.
    - The first phase of this project will be the construction of a fiber optic communication loop among Cedar Rapids Public Works, City Hall, the Cedar Rapids school district administration building, City Police, and the Lynn County Administration Building. This loop will run down 6^{th} Street, from 8^{th} Avenue to 1^{st} Avenue, and on 1^{st} Avenue, from 1^{st} St. W. to 8^{th} Avenue.

- The second phase of this project will involve the addition of pan-tilt-zoom observation cameras at various locations in the City.

Council Bluffs:

Other Related ITS Information:

- Mix of copper twisted pair and fiber optic network
- City of Council Bluffs uses the MARC NX traffic management system, with possible future upgrade to the ACTRA system

Davenport:

Other Related ITS Information:

- City of Davenport uses MARC NX traffic management system

Des Moines:

Statewide ITS Transit Projects in Operation:

- Des Moines Bus Schedules/Routes: Map of bus routes and schedules on Internet
- Des Moines Vanpool/Carpool: carpool/vanpool information and application forms on Internet
- GPS Transit Vehicle Tracking: Install GPS on transit vehicles for dispatching and tracking
- Des Moines CAD/AVL: Automatic vehicle location and computer-aided dispatch systems

Other Related ITS Information:

- Quicknet 4 signal system/traffic management system
- Des Moines and Iowa DOT have come together to share network of ITS cameras, 911, etc
- Metronet – agreement that ICS, Des Moines school district, City of Des Moines agree to work together to cooperate on fiber work in City
- Signal preemption
- Street corridors with fiber optic communications (other short sections in City may exist):
  - Portions of downtown grid
  - 2nd Avenue, downtown to north
  - E. 14th Street, downtown to north
  - Army Post Road
  - Beaver Avenue
  - 31st Street, I-235 to north of University Avenue
- Street corridors with copper wire (twisted pair) communications (other short sections in City may exist):
  - University Avenue and 63rd Street
- Street corridors with leased ICN communications (other short sections in City may exist):
  - Downtown grid
  - Hubbell Avenue, E. University to E. 29th Street
  - Fleur Drive, SW 9th Street, other corridors in south Des Moines
  - MLK Jr. Pkwy to Douglas Avenue, west to Beaver Avenue, north to Aurora Avenue, west on Aurora Avenue
  - Grand Avenue from downtown west to 56th Street
  - Euclid Avenue, 2nd Avenue to east of E 14th Street
  - 28th Street, Grand Avenue to I-235

Dubuque:
Other Related ITS Information:
- City of Dubuque uses the MARC NX traffic management system
- City has a good fiber conduit network throughout Dubuque (fiber conduit is included on roadway construction projects), but not much fiber optic cable has been installed
- Traffic communication center planned to be constructed Spring 2007
- City plans to expand interconnected traffic signal system and upgrade communications to fiber optic networks after traffic communication center is completed
- City will integrate pan-tilt-zoom observation cameras after traffic communication center is completed
- Downtown grid on old copper system (may not be conducive for true data communication)
- Fiber optic interconnected corridors include U.S. 20, U.S. 151, and other arterial roadways – these corridors run on independent MARC masters, and do not currently have communication with City offices
- Planned fiber optic expansion project Spring 2007 to bring U.S. 20 corridor fiber to City Hall to bring signal communications to City offices
- Planned fiber optic communications loop around City for future

Iowa City/Coralville:
Statewide ITS Transit Projects in Operation:
- CAMBUS Online Route Information: Transit route information available on the Internet
- Iowa City interactive Route Information Kiosks
- Iowa City Online Route Information

Other Related ITS Information:
- The City of Coralville has a wireless signal communication system (microwave)
- The City of Iowa City uses the MARC traffic management system, and hopes to upgrade to the Actra system in the future.
- Iowa City signal communication is primarily via copper twisted pair. A recent ICAAP project interconnected seven corridors via fiber optic communications. Downtown Iowa City has pretimed signals that are not interconnected.
- Iowa City is planning for a future signal preemption project for one major corridor; currently, the City's preemption is all hardwired.

Sioux City:
Planned Statewide ITS Transit Projects:
- Sioux City CAD/AVL

Other Related ITS Information:
- City has an older center computer system for approximately 60 of its 140 traffic signals. Fiber optic interconnect is along Lakeport Street and Outer Drive, with a planned fiber optic interconnect along Hamilton Boulevard.

Ottumwa (Region 6):
Planned Statewide ITS Transit Project: CAD/AVL

Region 8:
Planned Statewide ITS Transit Project: CAD/AVL

Region 10/Johnson County:
Planned Statewide ITS Transit Project: CAD/AVL