

March 2005

# ITS ARCHITECTURE

## for Metropolitan Sioux City Area

FINAL REPORT



CONSULTING GROUP, INC.

**ITS ARCHITECTURE  
FOR  
METROPOLITAN SIOUX CITY AREA**

**Final Report**

March 2005

Prepared for

**SIOUXLAND INTERSTATE METROPOLITAN PLANNING COUNCIL**

Prepared by

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## **1.0 INTRODUCTION**

The SIMPCO ITS Architecture is an effort by the Metropolitan Planning Organization to catalog the existing Intelligent Transportation Systems (ITS) in the area and create a coherent, forward-looking ITS architecture for the area. The application of ITS technology can improve the safety, efficiency, and cost-effectiveness of transportation systems, as well as improve the overall traveler experience. The Plan will provide valuable input into the transportation planning process by providing a basis for incorporating ITS in capital improvements plans and integrating ITS into the transportation system to address the region's needs.

ITS encompasses a wide variety of applications that incorporate intelligent or "smart" processes to improve transportation system performance and provide information to both private and commercial travelers. Traveler information allows the public to make better choices, such as avoiding unsafe conditions and congested areas, or selecting optimal routes and modes of travel. ITS can also benefit emergency responders, enabling them to reach sites more quickly and improving their ability to coordinate with other agencies and manage events more effectively. Ultimately, ITS enables the public to get the most out of its investments in transportation systems and decrease the level of expenditure required to expand or replace transportation infrastructure.

### **Study Objectives and Tasks**

The goals of the planning process undertaken by SIMPCO and the project consultant (SRF Consulting Group, Inc.) included:

- Reviews of past and present ITS-related activities and plans undertaken in the region by public and private entities
- Analysis of the current ITS infrastructure in the area to identify opportunities or deficiencies that may be address as part of the plan
- Preparation of a conceptual ITS network that integrates all appropriate projects and their technical and institutional aspects
- Estimates of proposed project costs, including ongoing operations and maintenance
- Proposed measures of effectiveness to be used with each of the projects
- A regional ITS Architecture

### **Disclaimer**

SIMPCO, the City of Sioux City, the City of South Sioux City, the City of North Sioux City, the City of Sergeant Bluff, Woodbury County, Federal Highway Administration, and local and state law enforcement/emergency response agencies have all contributed to this planning process. However, no recommendation or schedule in this document should be interpreted to mean that any agency has or will contribute any resource, financial or otherwise, to any proposed project contained herein. Any allocations of funds or other resources will only be done as part of an approved budgeting process.

## 2.0 INVENTORY

During September, 2004 SRF Consulting Group staff conducted meetings, interviews and on-site visits to collect information about existing ITS systems and ITS-related activities. The systems themselves were identified through committee meetings, planning work and other information obtained from MPO staff.

The inventory process consisted of obtaining system information and documentation from the systems' "stewards," those charged directly with the operation and maintenance. The operational scenario or policy was described, the hardware/software implementations documented along with system inputs/outputs and the intended customers. Frequently, the physical installations were also photographed for reference purposes.

Systems chosen for inventory generally fell into one of three categories: emergency response, traffic management, or traveler information. Additionally, several supporting or "ITS Infrastructure" systems were also inventoried, as they may be part of future ITS deployments.

The results of this systems inventory serve two purposes: 1) to document the framework in which future deployments will occur and; 2) to provide the basis for creation of a Regional ITS Architecture. Each system (when appropriate) has a section with general information, a brief description and a block diagram showing major system components and interconnections. The following systems were inventoried:

1. Condition Acquisition and Reporting System (CARS)/511 Traveler Information System
2. Bus Kiosks
3. Late Transfer Arrival Notification for Buses
4. Low Power FM Radio (LPFM)
5. Road Weather Information System (RWIS)
6. Sioux City Intersection Signals
7. Dynamic Message Signs
8. South Sioux City Intersection Signals
9. Emergency Response Dispatch Center (911 PSAP)
10. Public Safety Wireless Data System
11. Sioux City MPO Geographic Information System (GIS)
12. Transit/Paratransit Scheduling
13. Sioux City Wide Area Network
14. On-board Bus Video Surveillance System

## **Traveler Information**

### 2.1 Condition Acquisition and Reporting System (CARS)/511 Traveler Information System

System Location	Data input workstations located throughout Iowa, data collection, processing and telephony servers located in Atlanta, GA
Contact Person	John Whited, IA DOT Dean Deeter, Castle Rock Consultants
Geographic Area Served	Iowa – Statewide
Intended Customers	All motorists and commercial vehicle operators
O&M Responsibilities	Operations and maintenance are contracted by the Iowa DOT to Castle Rock Consultants (CRC)

#### **Data Flows (Inputs and Outputs)**

##### **Inputs:**

- Weather condition data from the RWIS system
- Traffic information
- Construction
- Road conditions
- Accidents
- Special events

##### **Outputs:**

- Web pages containing traveler information
- Voice messages for the 511 Telephony System
- Messages for DMS display
- Messages for LPFM Broadcast

#### **Communications Methods**

- Dial-up landline and cellular voice communications between system users and the system
- Internet data network between data collection, processing and output functions
- Dial-up connections to DMS control System
- Dial-up connections to LPFM control stations



## **Summary**

CARS is the traveler information software package used statewide in Iowa. It was developed by Castle Rock Consultants (CRC) through a pooled fund study that currently has 10 states participating. CARS is server-client software that is accessed through the web, with servers located in Atlanta, Georgia and maintained by CRC. Any additional development of the CARS system would be performed by CRC.

In November of 2002, Iowa became one of several states that have implemented a “511” traveler information number. Information is entered by trained and authorized personnel via statewide intra-net site. Agencies such as the State Patrol and Iowa DOT construction and maintenance are authorized to input data into the system. The types of information offered are generally restricted to traffic information, construction, weather information, road conditions, accidents, and special events. LPFM, 511ia.com, and DMS signs are also connected to the CARS central server.

An upgrade to the current CARS system is planned for early 2005, which will involve changes to the current publicly accessible webpage.

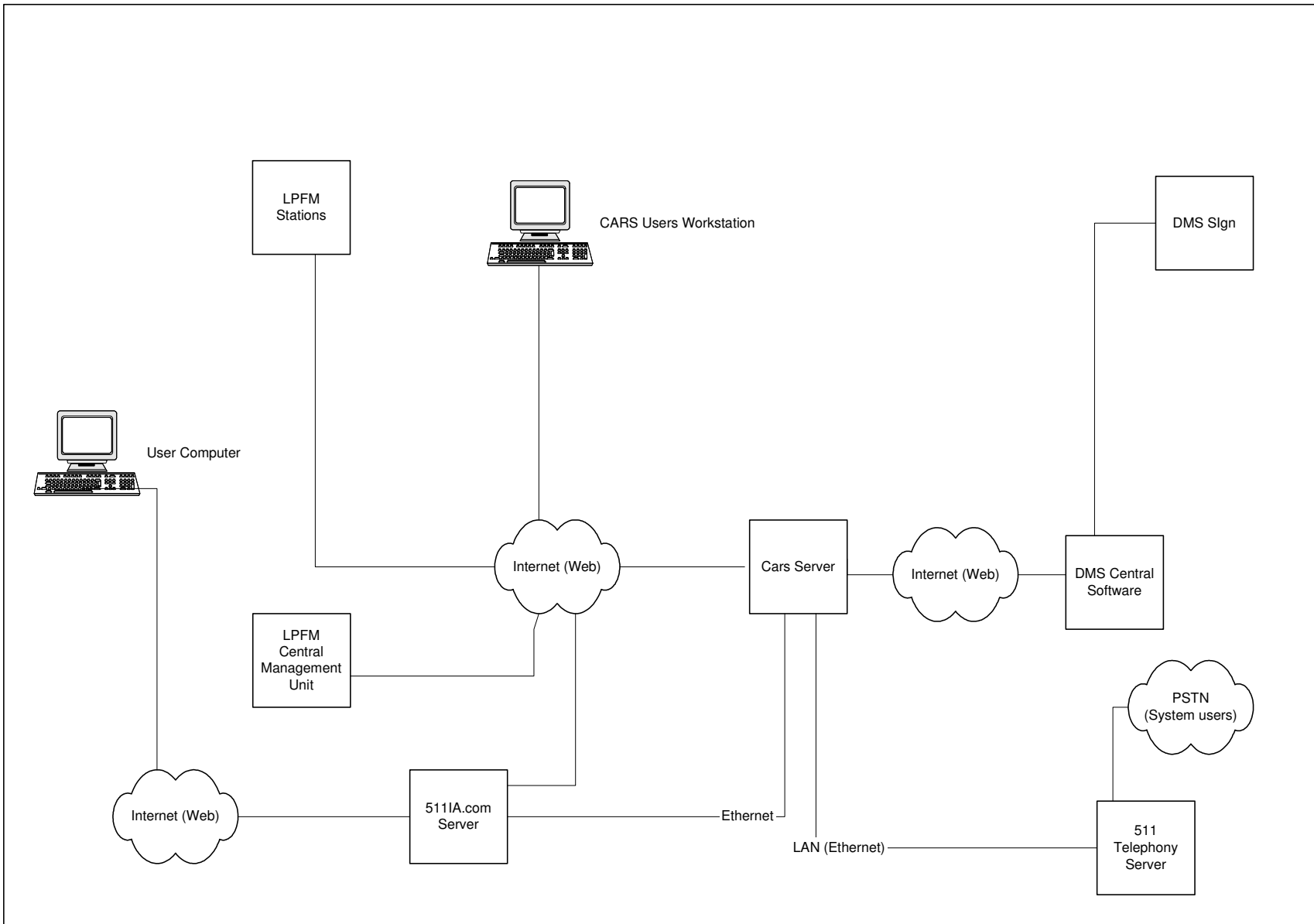


Figure 1  
Iowa (Telephony) Traveler Information System

## 2.2 Bus Kiosks

System Location	Sioux City, Iowa
Contact Person	Curt Miller, Sioux City Transit System
Geographic Area Served	Sioux City Metropolitan Area
Intended Customers	Transit Customers
O&M Responsibilities	Sioux City Transit System (Sioux City) CSI

### ***Data Flows (Inputs and Outputs)***

#### **Inputs:**

- Bus locations and heading

#### **Outputs:**

- Kiosk display of bus locations
- Web page display of bus locations

### ***Communications Methods***

- UHF (800 MHz) Voice Radio
- UHF (800 MHz) Data Radio

### ***Summary***

Eleven (11) regular transit routes currently operate in the Sioux City area. The bus fleet ranges in age from 1997-2004. The fares are \$1.50 cash-only payments for general fare. A month-long usage card is also available for \$40.00. Free transfers are offered to patrons within a 1-hour time limit.

There are currently three transit vehicle location kiosks within the Sioux City Metropolitan Area with an additional kiosk to be installed in 2004. The kiosks display bus locations and estimated bus arrival times updated every ten seconds.

Real-time communication to and from vehicles is accomplished via a voice radio system. A data radio within the bus sends bus location and time information to a repeater owned by Raycon, Inc., which transmits the information to a server located in the police department. The police department server converts the information into a text file and then transmits the information to a transportation web server at the MLK Transit Center, which is supported by CSI, Inc.. The information is then transmitted to the kiosks.

The communications to and from the vehicles are shown in Figure 2. Current fixed bus routes are presented in Figure 3.

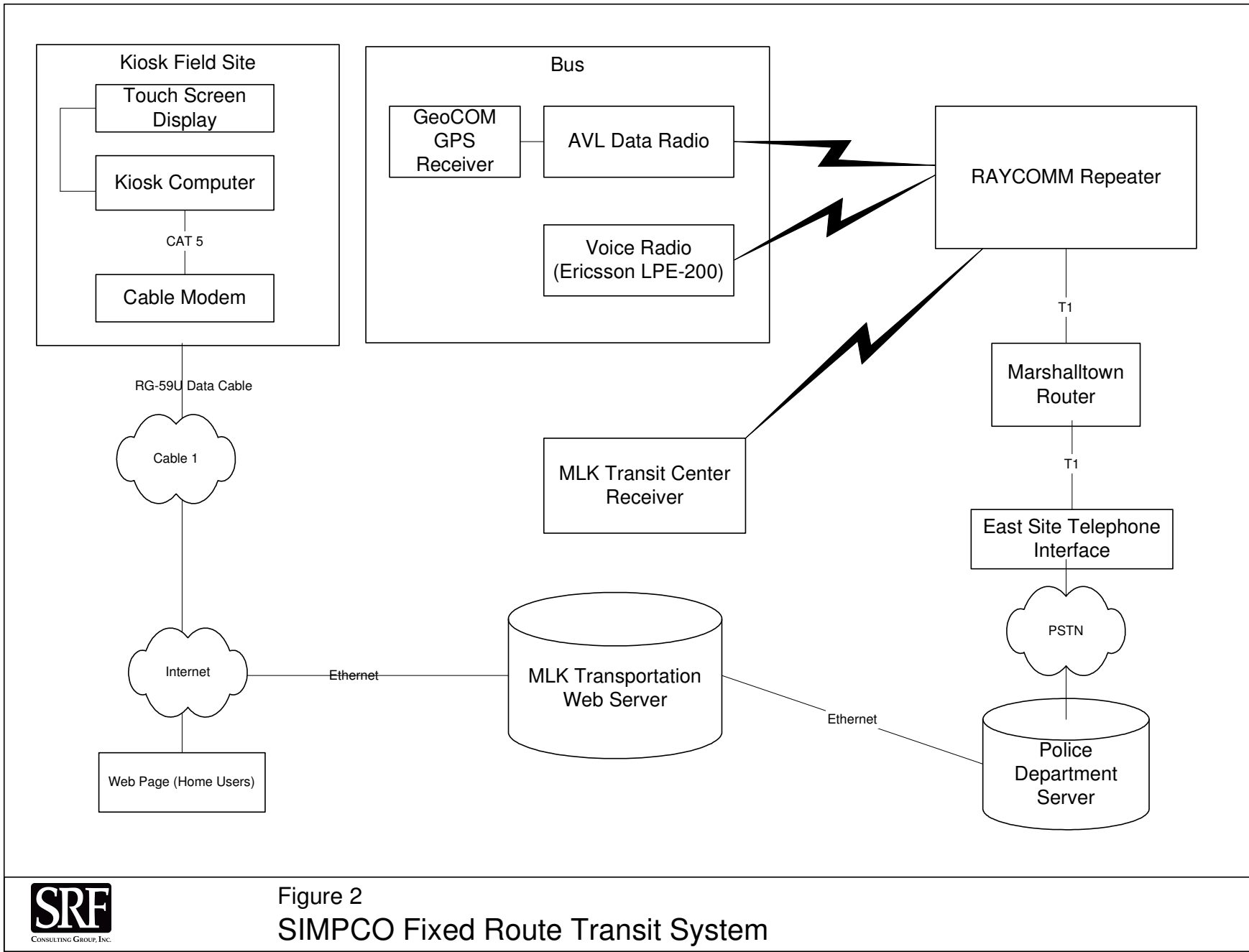


Figure 2  
SIMPCO Fixed Route Transit System



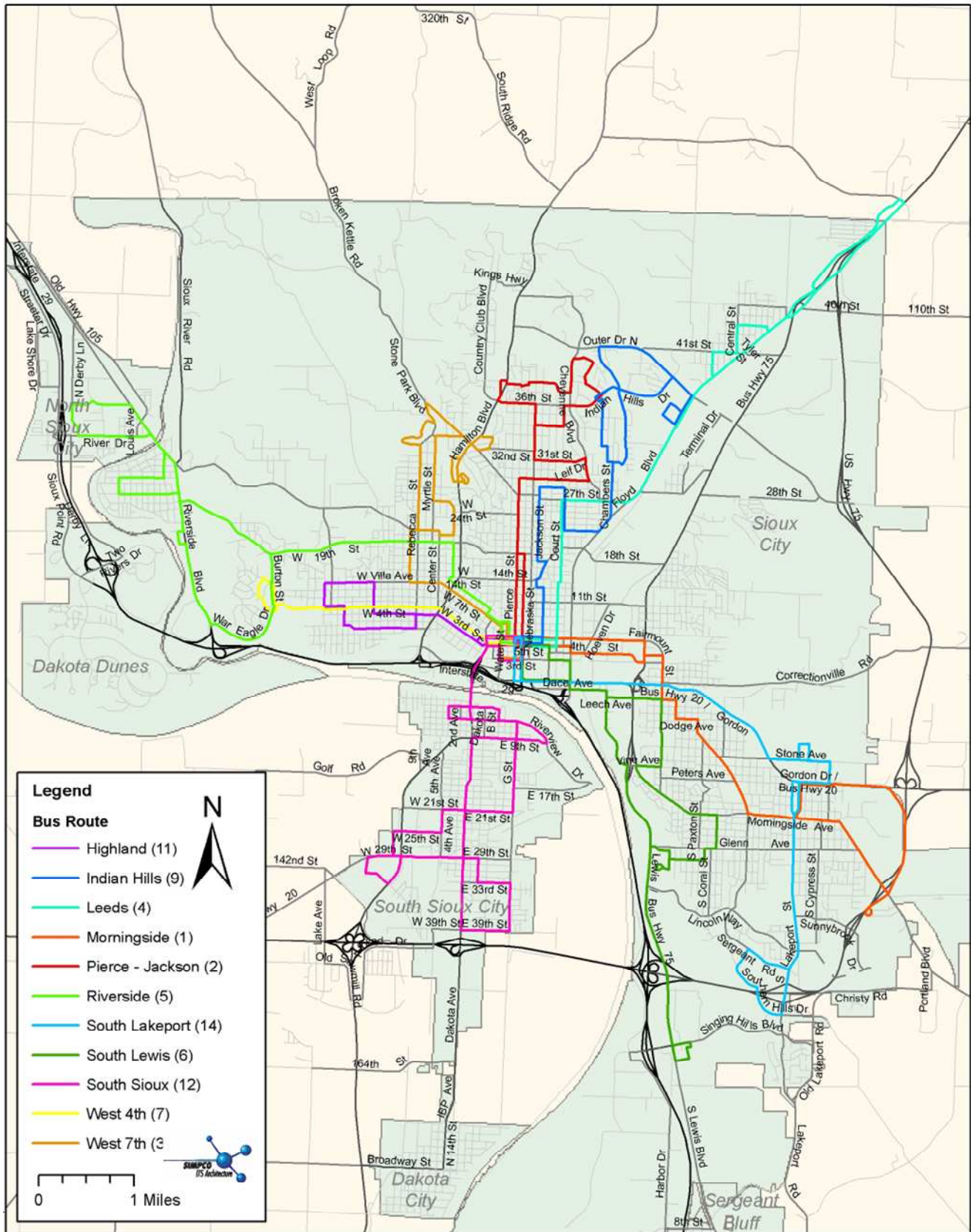


Figure 3  
Fixed Bus Routes



## 2.3 Late Transfer Arrival Notification for Buses

System Location	501-529 Nebraska St., Sioux City, Iowa
Contact Person	Curt Miller, Sioux City Transit System
Geographic Area Served	Sioux City Metropolitan Area
Intended Customers	General Public Bus Operators
O&M Responsibilities	Sioux City Transit System (Sioux City)

### ***Data Flows (Inputs and Outputs)***

#### **Inputs:**

- Activation Switch by transit personnel

#### **Outputs:**

- Late arrival alert

### ***Communications Methods***

- UHF (800 MHz) Voice Radio

### ***Summary***

The Sioux City Fixed Route Transit System uses a “pulsed” transfer timing system. This method of scheduling has all routes converging on the MLK Transit Center simultaneously to allow transfers from any route to any other route. Timing of arrivals and departures is critical under this scheme, since there must be sufficient overlap of busses to allow patrons to move from one bus to another.

If a bus is running behind its expected schedule the driver uses the on-board voice radio to alert the dispatcher to its late status. The dispatcher uses a switch to activate an overhead red light above the bus transfer station in the MLK transit center, which alerts the bus operators and the riders of a late bus. The buses then wait for the late bus’ arrival for transfer purposes.

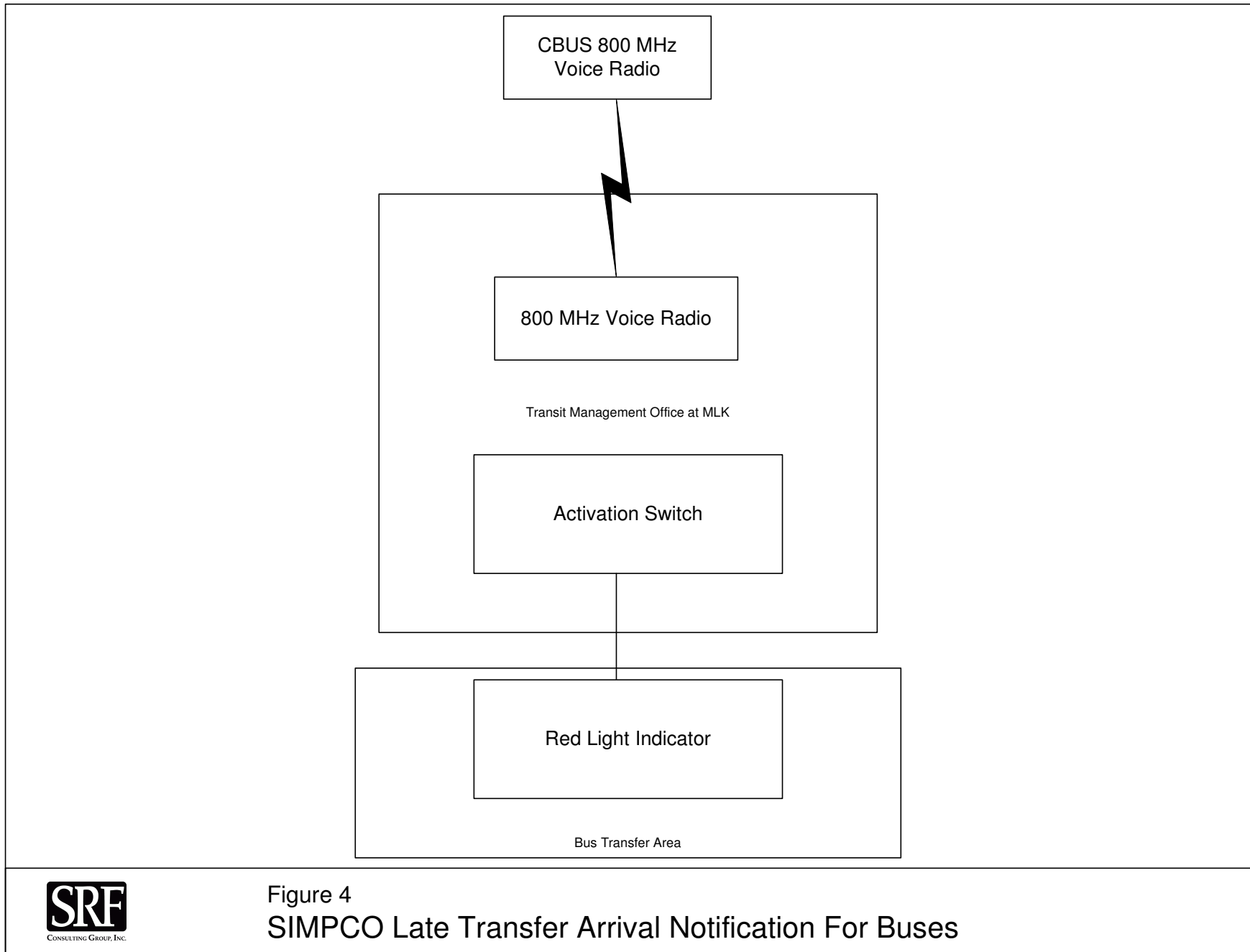


Figure 4  
SIMPCO Late Transfer Arrival Notification For Buses

## 2.4 LPFM System

System Location	Sloan: I-29 from Mile Post 119.2 to 130.8 DeSoto: I-80 from Mile Post 102.2 to 114.2 Adair: I-80 from Mile Post 72.5 to 84.5
Contact Person	Willy Sorenson, Iowa DOT
Geographic Area Served	10 mile radii surrounding the 3 system locations
Intended Customers	General Traveling Public
O&M Responsibilities	Iowa DOT maintains the equipment Castle Rock Consultants maintain the HAR software

### ***Data Flows (Inputs and Outputs)***

#### **Inputs:**

- Construction plans and status
- State traveler information
- Environmental information

#### **Outputs:**

- Construction information
- State traveler information
- Environmental information
- Radio station messages based upon the input information

### ***Communications Methods***

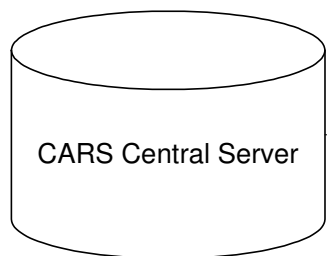
- Dial-up telephone connections from the CARS server to LPFM stations
- FM broadcast from the LPFM station to the traveler's radio

### ***Summary***

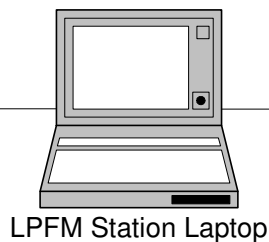
Low Power FM Radio is a Broadcast Traveler Information mechanism that delivers a pre-recorded message over an assigned FM radio frequency. Messages are generally recorded on an as-needed basis to inform travelers of situations, weather-related or otherwise, that may impact travel safety. Roadside signs indicate the appropriate channel to motorists.

LPFM control is a module of the CARS information management system used for a variety of transportation functions in Iowa. The LPFM radio stations are connected to CARS with dial-up 56K modems. At each LPFM site, there is a laptop computer and a radio transmitter that is connected to the laptop through the integrated headphone jack. The laptop then plays .wav audio files according to the instructions from the CARS central server. CARS will run messages on LPFM depending on an assigned priority number. If a message is considered high enough priority and is within a certain radius of the station location, it will be played on the LPFM station.

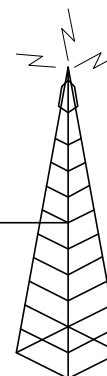
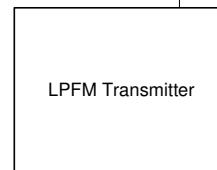




56 K Dial-up Modem



Analog Audio Cable



Radio tower



Figure 5  
Iowa Low Power FM (LPFM) System

## **Traffic Management**

### 2.5 RWIS

System Location	Approximately 52 sites placed throughout Iowa. Central processing is located in Ames, Iowa
Contact Person	Tina Greenfield, Iowa DOT
Geographic Area Served	Iowa – Statewide
Intended Customers	State of Iowa DOT
O&M Responsibilities	Operations and maintenance of the system are being performed under contract to the manufacturer, Surface Systems Inc (SSI) of St. Louis, MO.

#### **Data Flows (Inputs and Outputs)**

##### **Inputs (from field sensors to processing):**

- Temperature (air and ground)
- Wind speed/direction
- Pavement temperature
- De-icing chemical presence
- Frost conditions
- Pavement condition (dry, wet, ice, etc.)
- Humidity
- Precipitation

##### **Outputs (from processing to other systems (511, web site)):**

- Summarized data from the above inputs

#### **Communications Methods**

- Dial-up or radio transmission to roadside sites
- Internet from SSI to the central processing server in Ames, Iowa.

#### **Summary**

Iowa has deployed a Road Weather Information System (RWIS) to collect data along the major roadways in the state. Typically pavement temperature and condition, air temperature, ground temperature, wind direction, wind speed, frost conditions, and the presence of de-icing chemicals are monitored. The data from the sensors is typically used to determine what treatment to make to the roadway during winter months. During the rest of the year the RWIS stations are used to monitor weather conditions. The RWIS fills in the gaps in the Automated Weather Observing Site (AWOS) network and is also used by the National Weather Service for forecasting and monitoring of weather conditions around the state.

As shown in Figure 6, each station has a compliment of sensors manufactured by SSI, a company that supplies many States' RWIS equipment. Servers in Ames, Iowa request current information from each garage near an RWIS site via the department's LAN. The garage PC requests data from the RWIS site via either radio or telephone and forwards it back to the servers approximately every 10-15 minutes. The RWIS has a program that converts proprietary data into ASCII format, which is then transmitted into the ftp server. Anyone with a valid username and password can extract data from the ftp site and use it for forecasting and research.

Figure 7 shows the locations of RWIS and AWOS sites throughout Iowa.

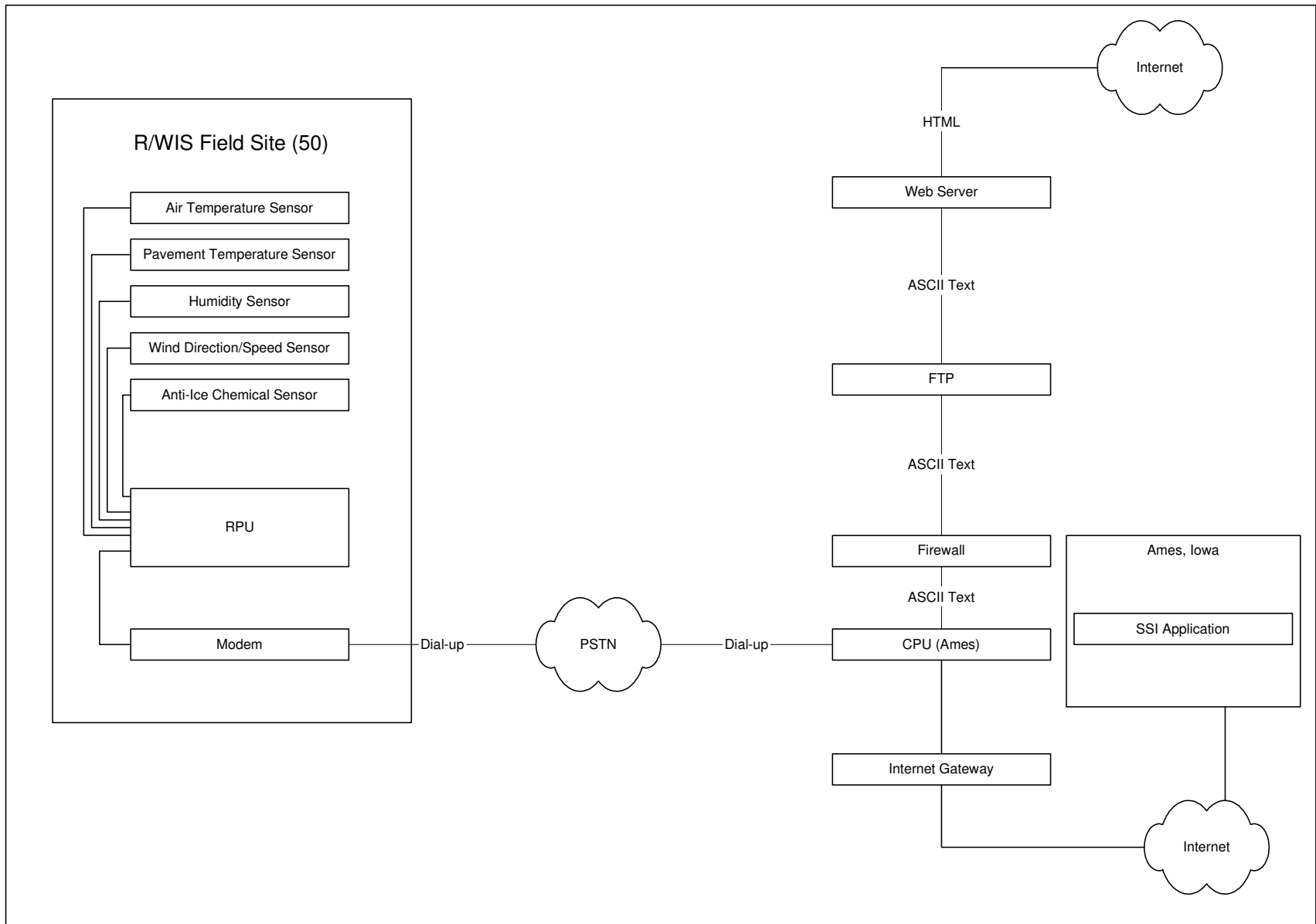
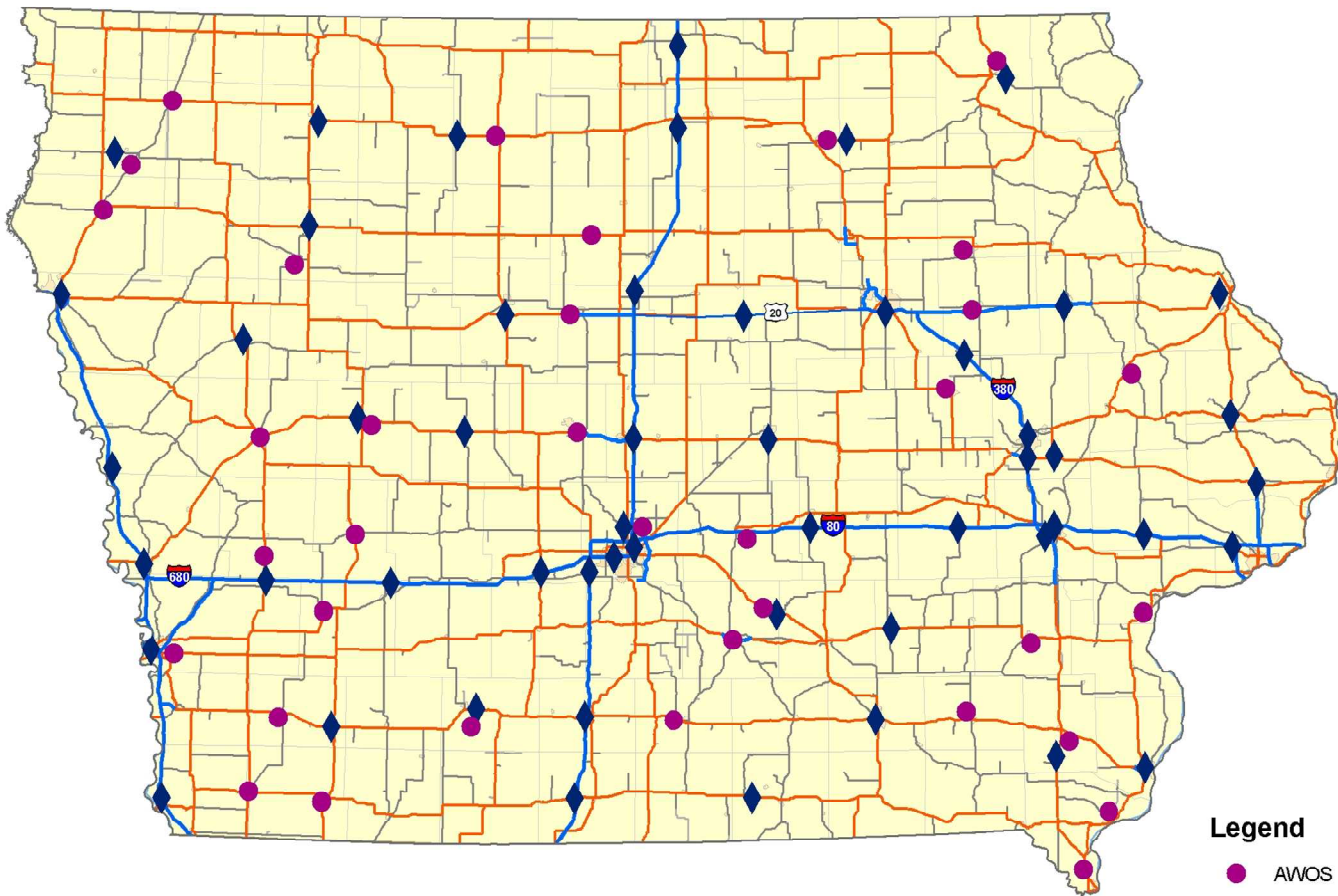


Figure 6  
SIMPCO Road Weather Information System



- Legend**
- AWOS
  - ◆ RWIS



Figure 7  
Iowa RWIS and AWOS Locations

## 2.6 Sioux City Intersection Signals

System Location	Sioux City, Iowa
Contact Person	Scott Carlson, Sioux City Traffic Coordinator
Geographic Area Served	Sioux City
Intended Customers	Motorists traveling in Sioux City
O&M Responsibilities	City of Sioux City Sign/Signal Shop 715 Omaha Sioux City, IA 51105

### ***Data Flows (Inputs and Outputs)***

- Traffic count data (from inductive loops/video detection)
- Pedestrian “walk” push button requests
- Signal operation timing plans
- Optical actuation for emergency vehicle preemption
- Railroad preemption

### ***Communications Methods***

Communications from control system(s) to roadside controllers is through a combination of Dial-up and dedicated leased links.

### ***Summary***

The City of Sioux City operates a traffic signal system covering the central business district (CBD) and the suburban business area to the east of the CBD. This system consists of 135 signalized intersections and a heterogeneous collection of 135 signal devices. Principal manufacturers used are TRANSYT, PEEK, and Eagle, with TRANSYT 1880-EL models being the most common (111 of the total).

The system uses vehicle actuation and time-of-day parameters to modify signal operation parameters, but does not use central coordination of the signals. Additionally, 3M Opticom Emergency Vehicle Preemption is used on six intersections to allow law enforcement vehicles to move more quickly through the system. The system also employs interconnects to railroad track circuits to allow for train traffic to preempt signal timing plans for safety purposes.

Actuation of signals is accomplished through two technologies: in-pavement inductive loops and machine vision-based video systems. The video systems are manufactured by PEEK and are used with PEEK compatible controllers (approximately 12 total).

Communications between central control systems and the individual intersections are accomplished through a dial-up link using a telephone connection to the signal controller or through the use of a leased data communications line. In the case of older signals using a master/slave configuration the remote connection is made to the master controller and then to slaves using copper twisted pair or fiber-optic cable in conduits between the intersections. The most common interconnection method is twisted pair, with fiber optics being only recently installed.

Two other major intersection signal systems are used in the immediate area: South Sioux City, Nebraska and Sergeant Bluff, Iowa. However both of these systems are far enough away from the Sioux City signals that no direct system coordination is maintained.

Figure 8 below show a schematic representation of the different configurations of intersection signals used in the Sioux City area.

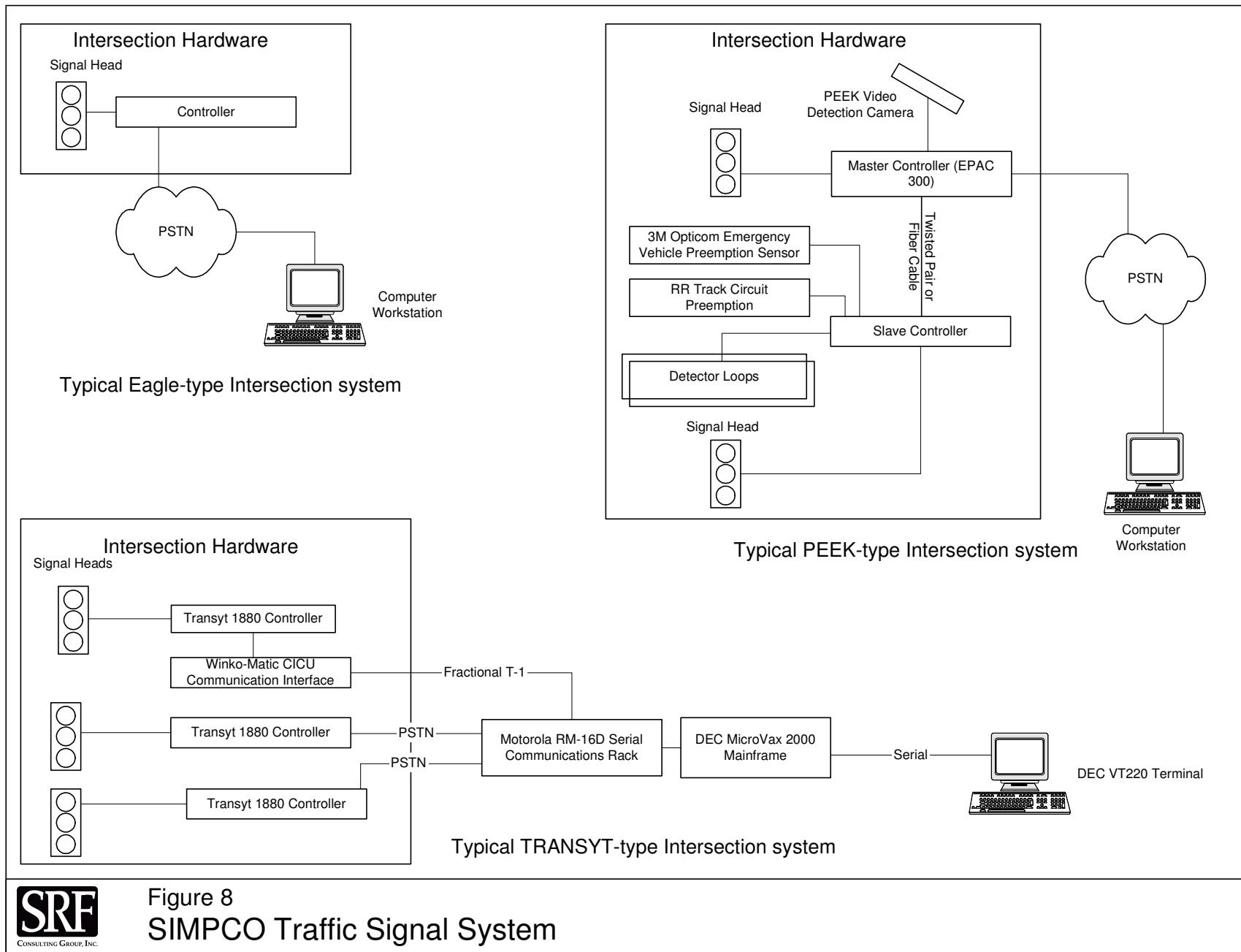


Figure 8  
SIMPCO Traffic Signal System





## 2.7 Dynamic Message Signs

System Location	Four (4) possible signs to be in place by FY 2009 (1 in FY 2005, 3 possible in FY 2009)
Contact Person	Dakin Schultz, Iowa DOT
Geographic Area Served	Iowa, Statewide
Intended Customers	All motorists and commercial vehicle operators
O&M Responsibilities	Iowa DOT Staff

### ***Data Flows (Inputs and Outputs)***

#### **Inputs:**

- Sign display commands

#### **Outputs:**

- Display confirmation signals
- Traveler messages

### ***Communications Methods***

- Internet connection between the CARS server and the DMS Central Control Software
- Dial-up telephone connections between the control servers and the signs in the field

### ***Summary***

There are four locations that have been proposed for DMS installations. At this time, it is envisioned that these would use the existing control system and would only require telephone service to be installed at the roadside to extend the current deployment. CARS software is being modified to control the DMS which allow for local control during normal business hours and the transfer of control during off peak times. The locations in the SIMPCO area being considered are shown below in Table 1. Figures 9 and 10 show a system schematic and a map of the DMS locations respectively.

**Table 1 – Proposed DMS Locations**

<b>Highway</b>	<b>Location</b>
I-29 NB	MP 142, Sioux City
US 77 NB	North of 21 <sup>st</sup> St., Sioux City
US 20 WB	East of US 75, Sioux City
US 75 SB	North of C80, Sioux City
US 77 NB	North of Broadway Street, S Sioux City
I-29 NB	MP 1, North Sioux City
US 20 EB	East of 110, S Sioux City
I-29 SB	MP 2, North Sioux City

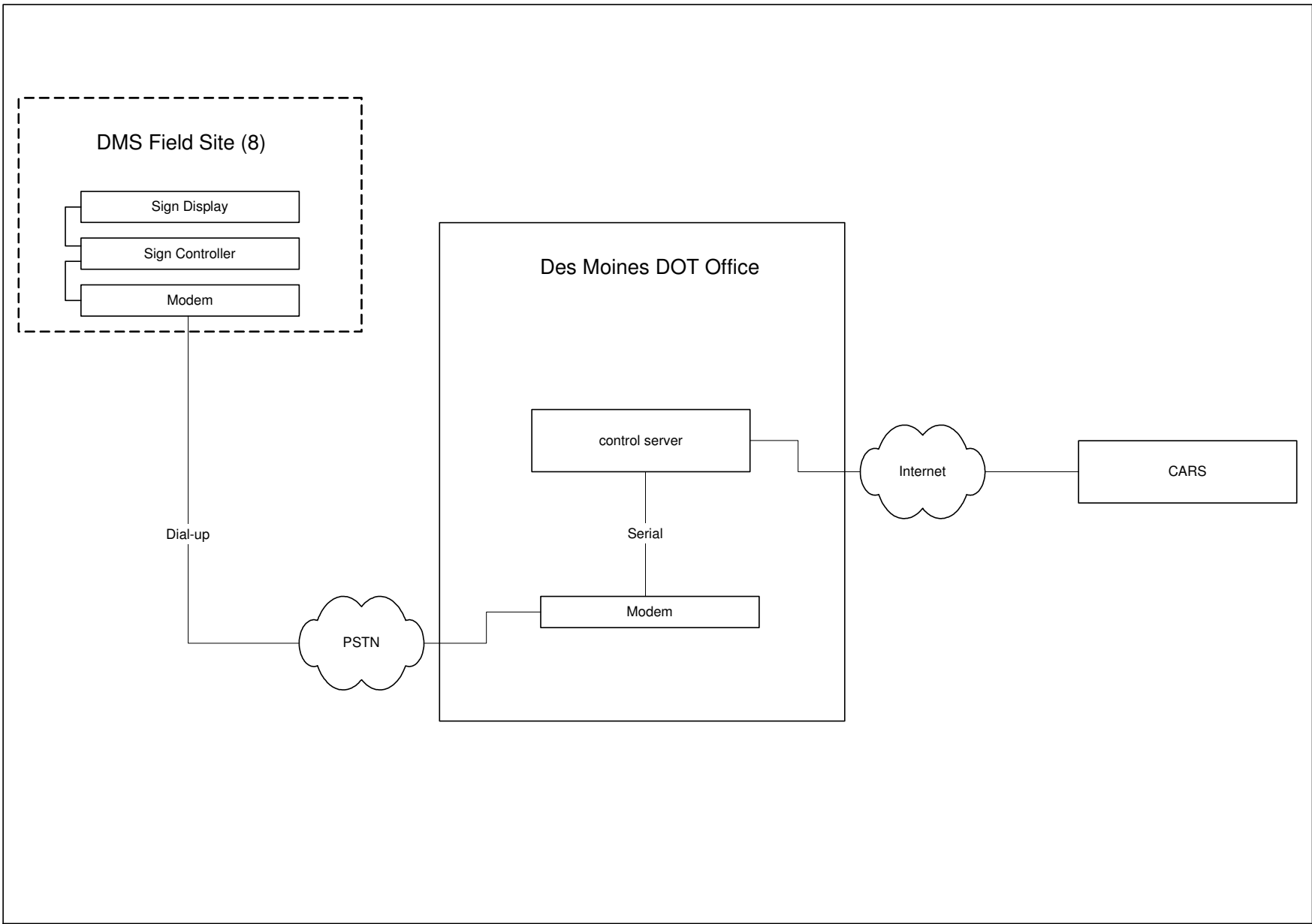


Figure 9  
Sioux City Area Dynamic Message Sign System



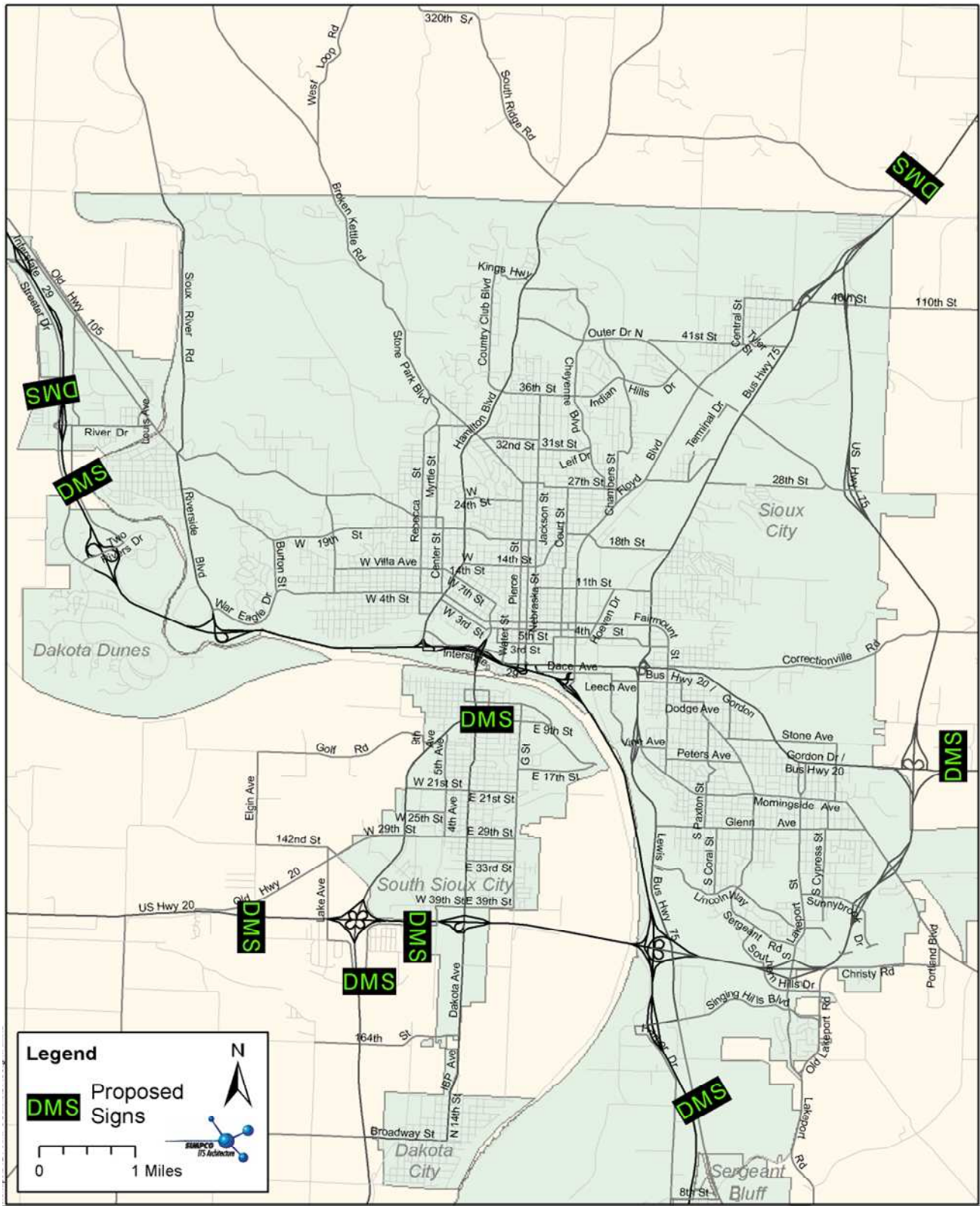


Figure 10  
Proposed DMS Locations

## 2.8 South Sioux City Traffic Signal System

System Location	South Sioux City, Iowa
Contact Person	Chad Kehrt, City Engineer, South Sioux City
Geographic Area Served	South Sioux City
Intended Customers	Motorists Traveling in South Sioux City
O&M Responsibilities	TBD

### ***Data Flows (Inputs and Outputs)***

- Traffic count data
- Pedestrian “walk” push button requests
- Signal operation timing plans
- Optical actuation for emergency vehicle preemption
- Railroad preemption

### ***Communications Methods***

Signal timing plans are generally update at the site of the controller (at intersection) and remote communications are not used.

### ***Summary***

The City of South Sioux City operates a traffic signal system centered on Dakota Avenue covering a total of 16 intersections. TCT 8000 series and Type 170 signal controllers from various manufacturers are used along with a single PEEK 3000 at Dakota Avenue and 48<sup>th</sup> Street.

The system uses vehicle actuation and time-of-day parameters to modify signal operation parameters, but does not use central coordination of the signals. Additionally, 3M Opticom Emergency Vehicle Preemption is used on two intersections to allow law enforcement vehicles to move more quickly through the system.

Signals are generally run in a time-of-day coordination configuration that does not require communications between the individual controllers.

A Traffic Signal Integration Study was completed by Olsson Associates in March of 2003 for the city. This study recommended replacement of older TCT signal controllers and interconnection of the system using an existing ATM/Fiber optic network already in place. Additionally, at-grade rail crossings have a significant impact on traffic flow. A project is currently underway to assess the utility of a train detection system that would display notices to travelers warning of delays.

## **Emergency Response**

### 2.9 Emergency Response Dispatch Center

System Location	Communications Center Sioux City, Iowa
Contact Person	Glenn Sedivy, Woodbury County Communications Center Director
Geographic Area Served	Sioux City, Woodbury County, Dakota Dunes and North Sioux City, S.D
Intended Customers	General Public
O&M Responsibilities	Woodbury County

#### ***Data Flows (Inputs and Outputs)***

##### **Inputs:**

- Emergency service requests
- Emergency responder status updates
- Outputs:
- Emergency responder instructions

##### ***Communications Methods***

- Land line telephone
- VHF/UHF voice radio
- WUHF data radio
- Ethernet LAN

##### ***Summary***

Due to the wide variety of users served by the system, several communications methods are used, depending on the department or service being dispatched. Incoming emergency (911) calls are handled by five incoming wireline telephone service trunks and five incoming wireless service trunks.

When a call is received, it is routed to an available dispatcher at one of five dispatch workstations in the Communications Center. Enhanced 911 caller identifier information is immediately presented to dispatchers, currently in Phase I form, with Phase II functionality becoming available by late 2004/early 2005. The dispatcher collects relevant information from the caller and enters it into HTE CAD400 software for incident management. The dispatcher then selects the appropriate responder and communicates instructions and details of the incident using the appropriate communications channel. For Sioux City Police an 800 MHz radio system is used, for others VHF (150 MHz – band) radios are used.

Dispatchers also have an Automatic Vehicle Location (AVL) system available, which uses a software package supplied by GeoComm of Niceville, Florida. This software provides dispatchers with a real-time geographic representation of the locations of 40 Sioux City Police Department vehicles. Police vehicles are equipped with Panasonic CF-27 notebook-style ruggedized computers that are connected to the computer aided dispatch system as well as to criminal justice and public record databases. Data is transmitted on the 800 MHz radio systems.

All radio and telephone communications are recorded using Dictaphone Freedom digital audio recorders and archived for legal uses.

Some functions of the call center are backed up at the Woodbury County Disaster Center, which allows for calls to be taken and radio communications to responders to be operated. However, this facility does not replicate the CAD software or AVL system capabilities.

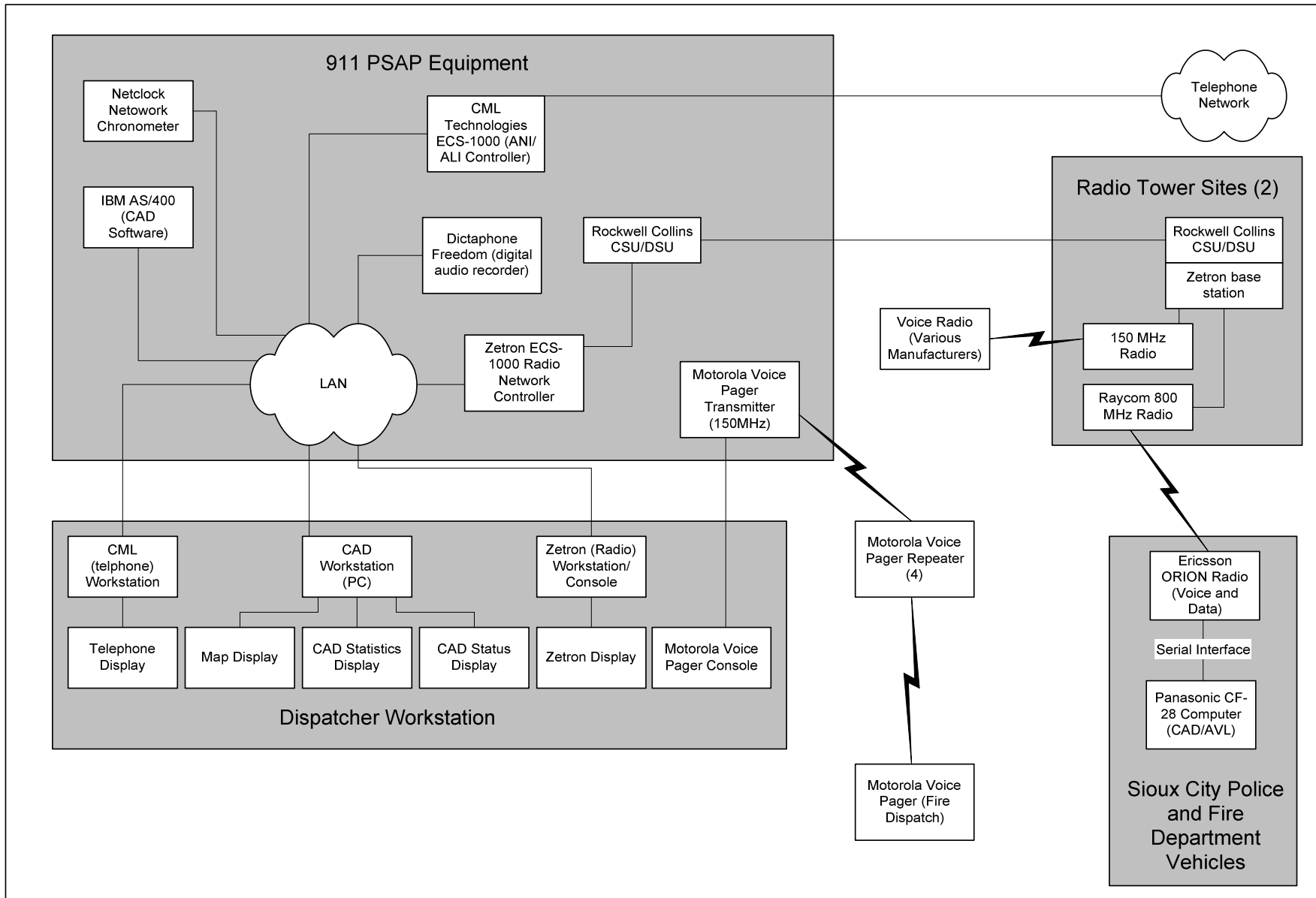


Figure 11  
 911 Emergency Response Dispatch System



## **Infrastructure/Other**

### 2.10 Public Safety Wireless Data System

System Location	South Sioux City, Nebraska
Contact Person	Lance Martin, South Sioux City Communications Director
Geographic Area Served	South Sioux City, Nebraska
Intended Customers	South Sioux City Police Officers
O&M Responsibilities	South Sioux City Police Officers

#### **Data Flows (Inputs and Outputs)**

##### **Inputs:**

- Live data from CCTV cameras

##### **Outputs:**

- Video output in patrol cars

#### **Communications Methods**

- Ethernet over fiber optic networking
- High-speed wireless data communications

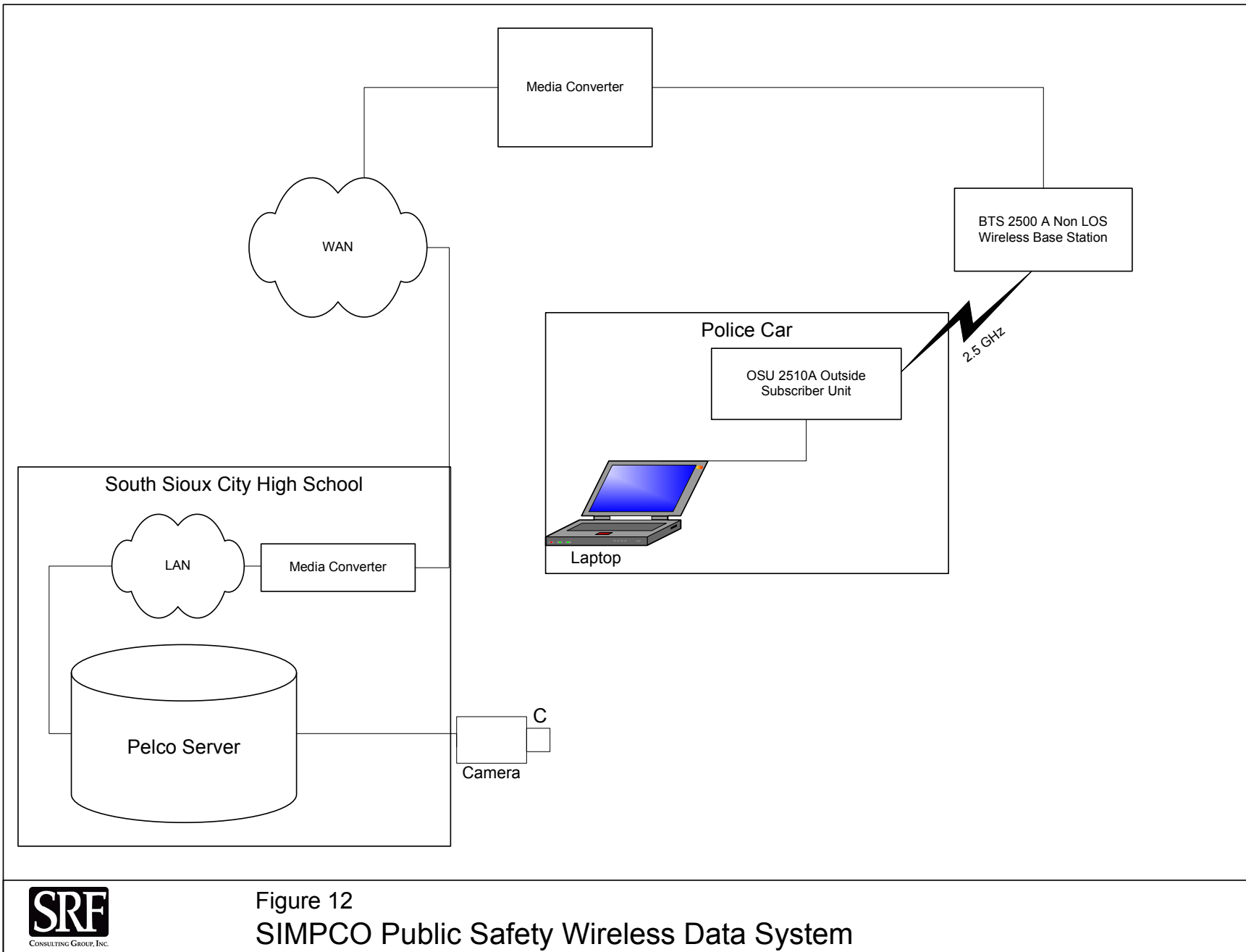
#### **Summary**

The South Sioux City Public Safety Wireless Data System allows full-motion digital video to be delivered to police vehicles from any one of a number of CCTV security systems installed at area schools. Pentium notebooks are used to view the video received from data radio within the patrol car. Patrol cars can view the video in South Sioux City, Dakota County and Sioux City, Iowa. There are currently four patrol cars equipped to view the video. An additional eight cars will be equipped during 2004.

The video is digitized by four Pelco PelcoNet digital video servers/recorders located at the South Sioux City Senior High School (3301 G St, So. Sioux City, NE 68776). The digitized video is then transmitted over the WAN to eight different 2.5 GHz NextNet wireless access points. The system is a non-line-of sight wireless system so the patrol cars can access the information anywhere within the signal. The wireless system is separated into virtual LANs (VLANs) with a dedicated VLAN for public safety that isolates the video traffic from the public internet traffic to ensure security.

This system is capable of delivering multi-megabit data speeds to in-motion vehicles while the vehicle is in range of one of the access points.





## 2.11 Sioux City MPO GIS

System Location	Sioux City, Iowa
Contact Person	Jill Mascarello, SIMPCO
Geographic Area Served	Metropolitan Planning Area Boundary
Intended Customers	Other governmental entities, including Sioux City departments, Sioux City MPO, and Woodbury County government, in addition to some public agencies.
O&M Responsibilities	Sioux City GIS Staff

### ***Data Flows (Inputs and Outputs)***

#### **Inputs:**

- Roadway information (locations, names, classifications, other attributes)
- Political boundary information
- Facility management information (emergency responder locations, infrastructure types, locations, etc.)
- Terrain elevation data
- Aerial photography data
- Population/demographic data
- Property ownership data
- Land use/Land cover data (wetland, vegetation, etc.)
- Event (crime, accident) data

#### **Outputs:**

- Maps displaying the input information
- Statistical analysis of data

### ***Communications Methods***

There are currently two full time employees who maintain GIS data and provide GIS services to the MPO. A variety of services are performed, including data capture, analysis and application development.

The primary tools of the GIS are ESRI ArcView versions 3.3 and 9.0 (3 concurrent user licenses). MPO data is stored on a Novell Netware server housed at the MPO offices.

Work is generally performed on Windows XP based computers. Each government entity has its own database to maintain. The GIS users in the area meet once per month to exchange information. Updates are performed as needed. There is no “central clearinghouse” for information so the meetings or phone calls are used to exchange data

with other entities. Data transfer is arranged on an ad-hoc basis, usually by an electronic (FTP) or physical (CD-ROM, DVD) medium.

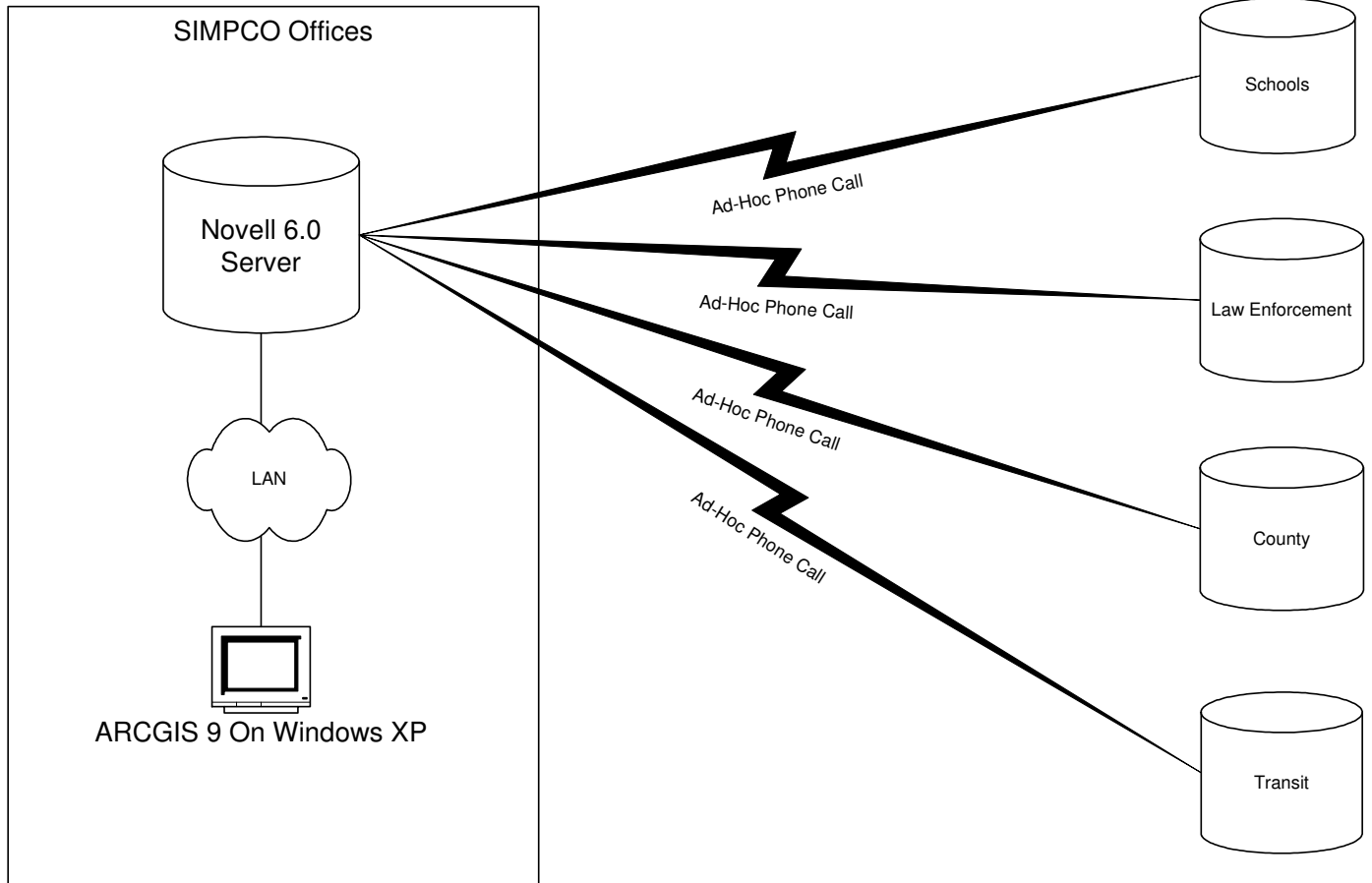


Figure 13  
SIMPCO GIS System

## 2.12 Transit/Paratransit Scheduling

System Location	SIMPCO 4th Floor Office 507 7th Street Sioux City, IA 51102
Contact Person	Curt Miller, Sioux City Transit System Sandy Langel, Siouxland Regional Transit System
Geographic Area Served	Sioux City, Iowa urban area along with the eleven regular transit routes, plus ¾ mile in any direction
Intended Customers	Mobility impaired transit customers
O&M Responsibilities	Sioux City Transit System (Sioux City)

### ***Data Flows (Inputs and Outputs)***

#### **Inputs:**

- Passenger registration information
- Passenger eligibility data
- Trip origin, destination and time requests

#### **Outputs:**

- Trip manifests
- Driver assignments
- Ridership reports

### ***Communications Methods***

- Paper Documents
- E-mail
- Telephone
- UHF Voice Radio

### ***Summary***

SUMS (Siouxland Urban Mobility Service) is provided by the City of Sioux City Transit System. SUMS offers Monday through Saturday ADA paratransit service within the Sioux City urban area along with the eleven regular transit routes, plus ¾ mile in any direction.

All persons riding must be certified as disabled. The Transit Manager reviews the applications and eligibility cards are issued that can be used for eligibility on any paratransit system in the United States.

Reservations are normally made one to fourteen days prior to the trip. A 24-hour notice is required for most reservations. Fares range from \$3.00 to \$18.00 per one-way trip depending on the level of service needed. Five buses are in operation Monday through Friday, two buses are used on Saturday and there is no service on Sunday. SUMS transports an average of 3,000 passengers per month.

Rider and trip information arrives via telephone or electronic mail. The call center representative receiving the trip information inputs it into a DOS-based automated dispatch software named PTMS by Automated Business Solutions. The trip manifest is printed the night before. System outputs are generally printed and physically delivered to the appropriate driver or manager.

Real-time communication to and from vehicles (for trip cancellations “no-shows”, etc.) is accomplished via an 800 MHz voice radio system.

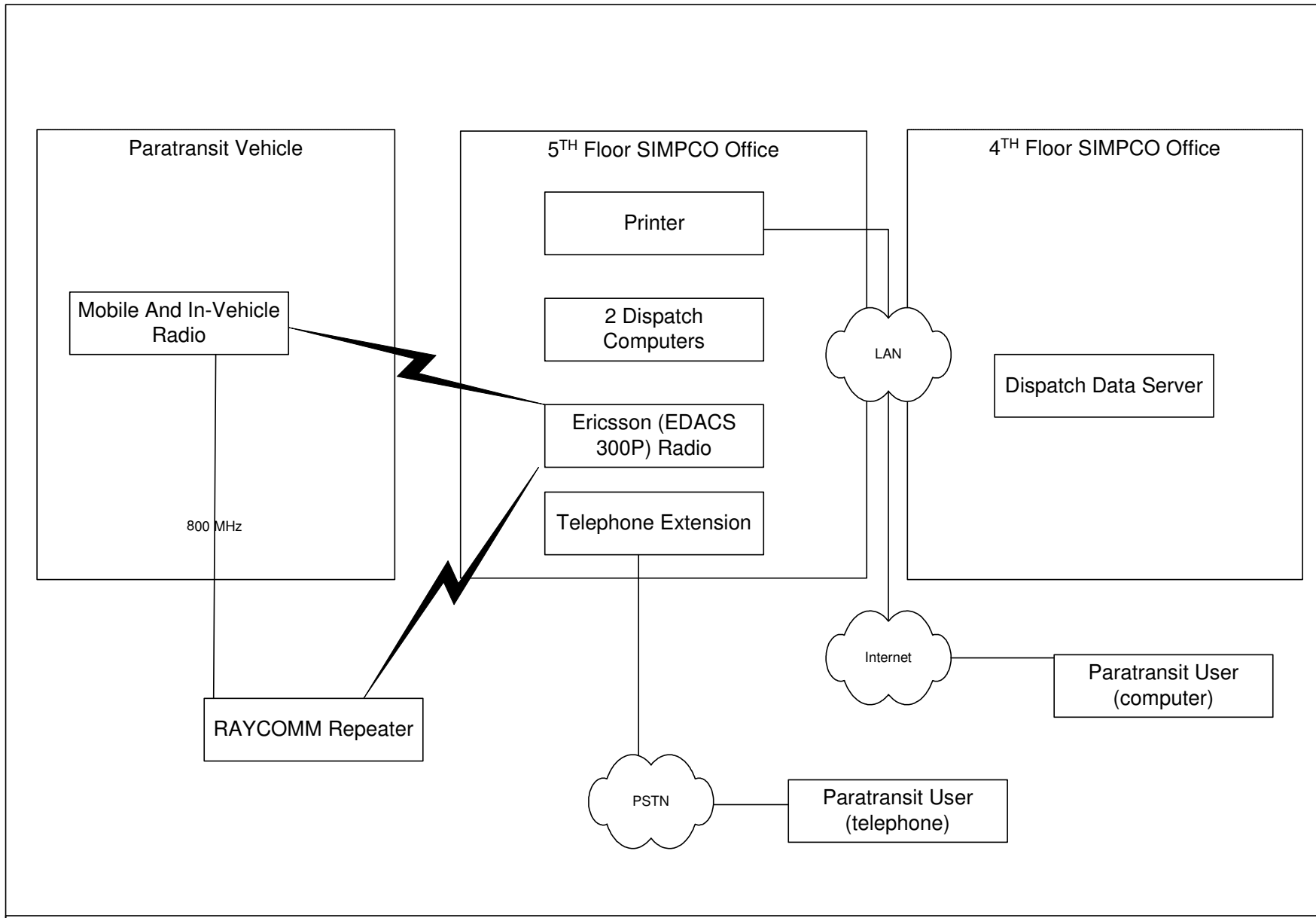


Figure 14  
SIMPCO Paratransit System

## 2.13 Sioux City Wide Area Network

System Location	Sioux City, Iowa
Contact Person	John Obermeyer
Geographic Area Served	City/County Facilities in the Sioux City area
Intended Customers	City and County Employees
O&M Responsibilities	Various (see summary)

### ***Data Flows (Inputs and Outputs)***

Various (General purpose data network)

### ***Communications Methods***

- TCP/IP communications over a variety of media including:
- 100BaseT Ethernet using Category 5 UTP cabling
- 100BaseFX Ethernet using multi-mode fiber optic cable
- 1000BaseLX using multi-mode fiber optic cable

### ***Summary***

To facilitate the exchange and availability of information between various entities in Sioux City, a Metropolitan Area Network (MAN) has been deployed to connect the Local Area Networks (LANs) at each facility. This MAN is a general purpose network, supporting emergency response communications, data archiving, file storage, printing functions, billing and general office tasks.

The LAN/MAN environment uses a hub-and-spoke topology to connect facilities together. The MLK Transit Center at 5<sup>th</sup> Street and Jackson Street is the hub for the fiber optic backbone, which connects to the Woodbury County Courthouse, City Hall, Police Station, Western Iowa Technical College, Fire Station #3, and Library. Each of these locations also maintains a LAN, which is connected to the MAN. The fiber from MLK to the airport and Western Iowa Technical College is not currently in use. There is also a fiber connection between the Sioux City Police Department and the South Sioux City Police Department. This connection provides a dedicated voice circuit between the two 911 centers and also aids in law enforcement data sharing.

The network is not currently maintained by any specific entity. The facilities manager of the building performs any needed maintenance that presents itself.

Western Iowa Tech is also the hub for the Iowa Communications Network (ICN). The ICN is an Asynchronous Transfer Mode (ATM) fiber optic network maintained by the State of Iowa that runs throughout the state of Iowa that connects approximately 50% of the schools in the state and is also connected to the state law enforcement facilities. The ICN is not connected to Sioux City's fiber network.



The standard operating system used by file and network services servers is Novell NetWare. Desktop PCs and workstations are MS 2000 XP systems with various hardware configurations depending on intended usage and age of the system. However, specialized and legacy systems may also be connected to this network.

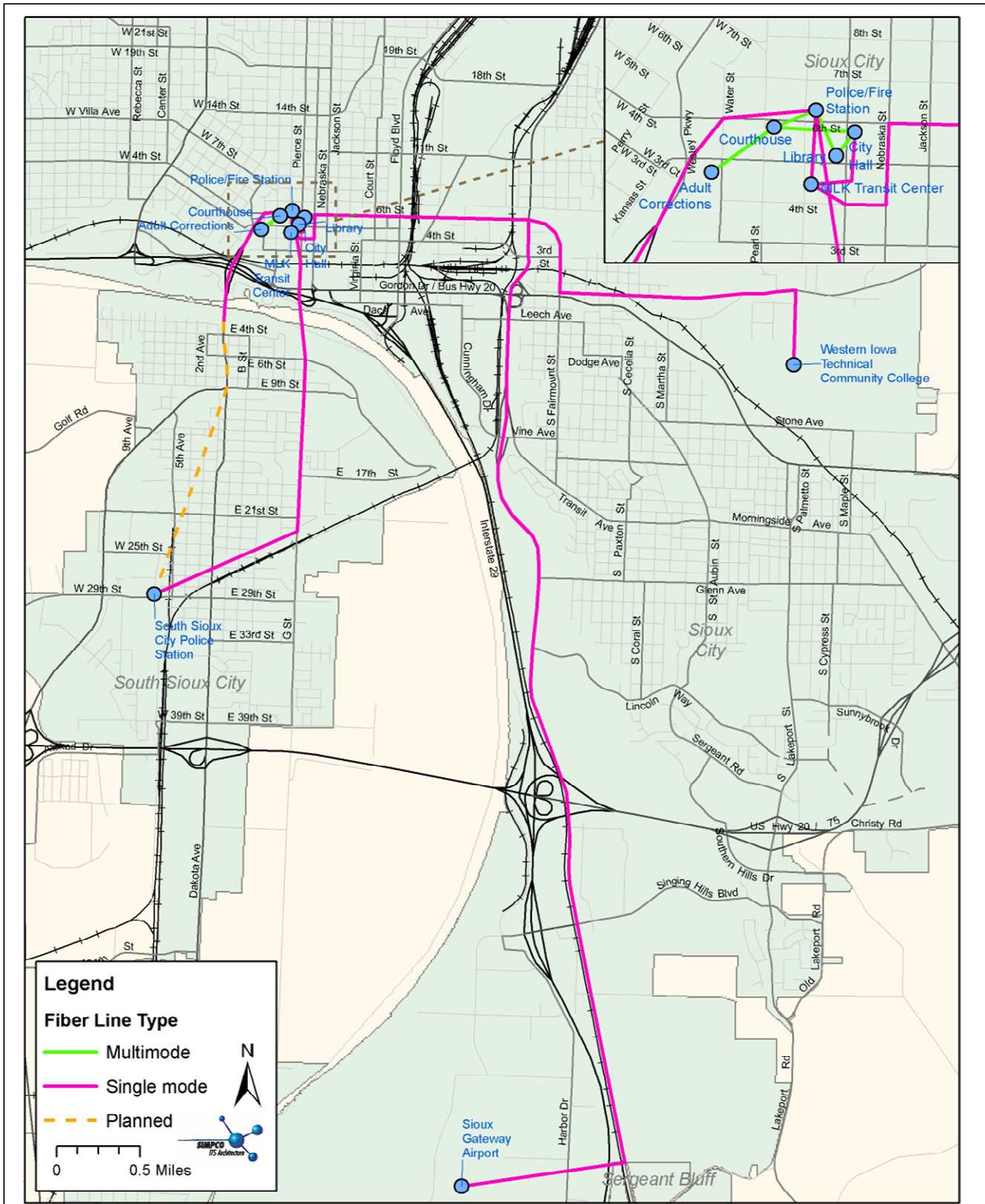


Figure 15  
 Fiber Facility Connections (routing may not geographically correct)

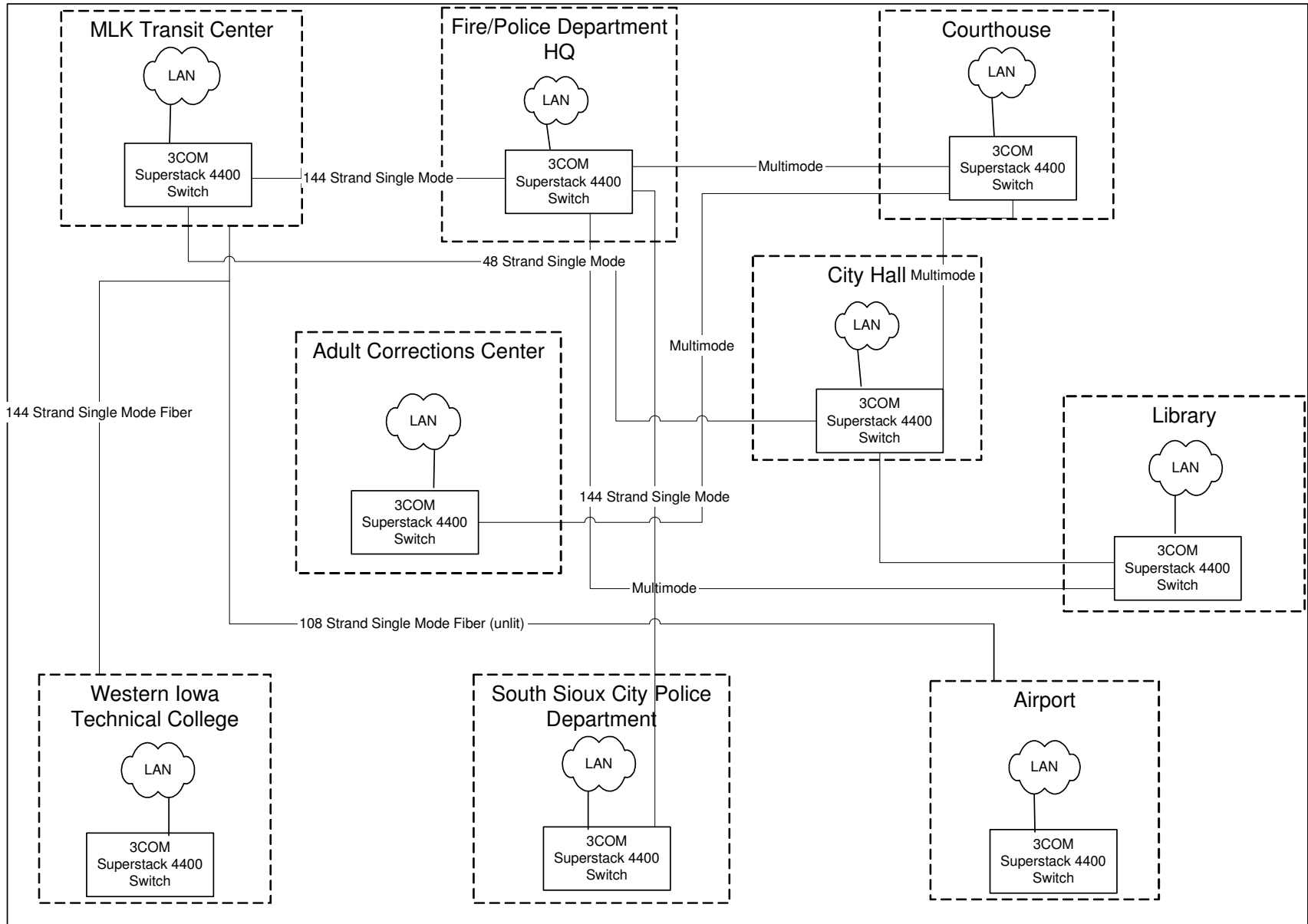


Figure 16  
SIMPCO Metropolitan Area Network

## 2.14 On-board Bus Video Surveillance System

System Location	4 buses in the Sioux City Transit System
Contact Person	Curt Miller, Sioux City Transit System
Geographic Area Served	Sioux City Metropolitan Area
Intended Customers	Public agencies
O&M Responsibilities	Sioux City Transit System

### ***Data Flows (Inputs and Outputs)***

#### **Inputs:**

- Live video from on-board cameras
- Day, date, time
- Driver ID
- Speed
- Brake usage
- Turn signals

#### **Outputs:**

- Video recording displaying all of the above inputs

### ***Communications Methods***

Data storage devices are physically removed from the busses for review at computer workstations. No electronic data transfer is used by this system.

### ***Summary***

Four digital Radio Engineering Incorporated (REI) cameras are installed on Sioux City transit buses for monitoring purposes. The cameras display day, date, time, driver ID, and vehicle speed. Braking and turn signal use is also recorded through an interface to the vehicle's electrical system.

The cameras are connected to a digital video recorder with a removable hard drive. The video is only viewed when needed and information is not stored or archived. The recorder is allowed to loop and the information is written over approximately every 30 days. If a video segment needs to be viewed the hard drive is detached from the camera and viewed at a digital video workstation in the transit management office.

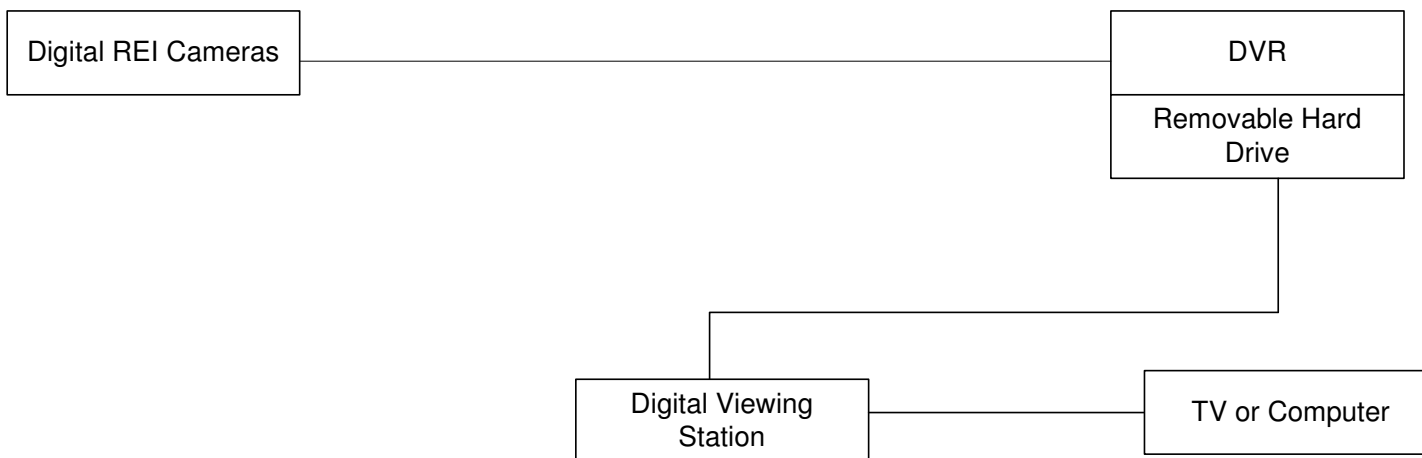


Figure 17  
SIMPCO On-Board Bus Video Surveillance System

### 3.0 IDENTIFIED ISSUES

#### 3.1 Issues Identification Process

The ITS Architecture draws upon several sources to determine the issues in the region that could be addressed through the use of ITS. The *“Traffic Signal Systems Evaluation and Conceptual Intelligent Transportation Systems Plan”* prepared in 2004 for the City of Sioux City and the *“South Sioux City Traffic Signal Integration Study”* prepared in 2003 provided input into the “baseline” listing of issues.

In all, the two studies listed some 83 issues in the region. To further expand this list and begin a prioritization process, a workshop was held on November 3, 2004 with a group identified by SIMPCO staff as stakeholders in the region. The goal of the workshop was to describe the compiled list of issues, and provide an opportunity for participants to rank those that they saw as the highest priority. Scoring was based on a weighted-vote approach, where each participant was given two each of high, medium and low priority votes. The votes were then given point values of three, two and one point respectively.

Following the workshop, SIMPCO staff requested that an on-line version of the workshop be created and made available to those invited to the workshop, but unable to attend. The web-based version of the voting form was created by SRF Consulting Group, and made available to invitees from December 13 through the 27. Eight additional responses were received this way.

**Table 2 – SIMPCO ITS Architecture Interviewees (November 2004)**

<b>Name</b>	<b>Agency</b>
Jim Mcree	Nebraska DOT
Scott Carlson	City of Sioux City – Traffic
David Carney	City of Sioux City
Jim Brachtel	FHWA – Iowa Division
Bruce Hunt	FHWA – South Dakota Division
Roger Milligan	Woodbury County Sec. Roads
Gary Brown	Woodbury County EMA
Jeff Hanson	SIMPCO
Jon Cater	FHWA – Iowa
Matt Tobias	SIMPCO
Jill Mascarello	SIMPCO
Sheldon Harrison	SIMPCO
Willy Sorenson	IA DOT
Rich Michaelis	IA DOT
Terry Keller	SD DOT
Dakin Schultz	IA DOT

### 3.2 Identified Issues

This workshop process and consultation with SIMPCO staff and committee members resulted in narrowing the initial 83 issues to the list of 16 described below.

**Table 3 – Identified Issues**

<b>Emergency Response Related Issues</b>
A. Improve ability of emergency response agencies to coordinate actions and communicate information
B. Decrease response times for emergency responders
<b>Traffic Management Related Issues</b>
A. Improve functionality of area signal systems
B. Better manage the traffic impacts of at-grade RR crossings
C. Decrease the incidence of red-light violations
D. Improve automated traffic counting/vehicle classification data
E. Oversized truck loads striking freeway overpasses
F. Improve temporary traffic management capabilities
<b>Maintenance Related Issues</b>
A. Improve coordination for maintenance and deployment of regional information technology infrastructure
B. Improve ability for area signal systems to be administered/managed
C. Reduce roadway icing impacts
<b>Transit and Traveler Information Related Issues</b>
A. Improve 511 system interoperability
B. Decrease cost to users for 511 service/expand availability
C. Improve information collection and distribution for construction events
D. Improve the dissemination of traveler information
<b>Integration</b>
A. Improve operational/conditional data sharing between jurisdictions

#### 3.2.1 Emergency Response Related Issues

Emergency response issues are related to the process of receiving requests for emergency assistance, selecting and dispatching an appropriate responder, and providing the assistance to the requestor. These issues were identified with the input of the staff that operates the 911 call facility, as well as the police and fire crews.

#### A. Improve Ability of Emergency Response Agencies to Coordinate Actions and Communicate Information

As with most regions, there are several emergency response agencies that serve the population. Police, fire, ambulance and others such as hazardous materials response teams coordinate to appropriately address the situation. At this time, the primary mechanism for coordination is the Public Safety Answering Point (PSAP), which provides communication to and from the units in the field.

Although there are tactical and mutual assistance channels available for center-to-center and unit-to-unit communications, there is not a unified wireless communications structure for direct communications between all emergency responders.

#### B. Decrease Response Times For Emergency Responders

While the Siouxland area is served by well implemented emergency services dispatch facilities, the ability of individual responders to arrive on-scene can be affected by traffic conditions and intersection signal delays.

This situation is exacerbated by the central location of the regional medical facility (St. Luke's Regional Medical Center) in the central business district of Sioux City, which has complete signalization at every intersection. Although individual delays may not be substantial, the cumulative effect can delay arrival times by several minutes if stops are made. If stops are not made, collisions between emergency vehicles and regular traffic can result.

### 3.2.2 Traffic Management Related Issues

#### A. Improve Functionality of Area Signal Systems

Related to the management of the signal system, older sections lack the functions of newer installations. Functions like vehicle detection, vehicle classification, speed measurement and various programmability options are often simply not available in older equipment.

#### B. Better Manage the Traffic Impacts of At-grade Railroad Crossings

Both the Sioux City and South Sioux City central business district have rail corridors with at-grade crossings and long (up to 8000 foot) trains moving through the corridors several times per day. These blockages can have substantial traffic impacts on local flow, as well as causing off-ramp backups onto the Interstate 29 main line.

A secondary impact is on emergency vehicle routing, which may have their routes temporarily blocked by trains.



### C. Decrease the Incidence of Red-light violations

As with many municipalities, red-light violations are a significant safety issue in cities in the Siouxland Area. Perpendicular impacts are among the most dangerous in terms of injury and have substantial costs both for the victims and for society through increased costs of insurance.

A study completed in December of 2000 by the Center for Transportation Research and Education (CTRE) at Iowa State University found one intersection in Sioux City averaged 2.24 red light violations per hour, or 5.23 per 1000 vehicles. This same study found that the estimated costs of red light violations from 1996-98 totaled \$5,369,499. A number that reflected 335 crashes including one fatality and 322 injuries.

### D. Improve Automated Traffic Counting/Vehicle Classification Data

One of the most critical elements of transportation planning is the collection of accurate and complete data. Several methods can be used to collect vehicle counts and classification, including manual observation, permanent automatic traffic recorders and portable, non-intrusive devices.

At this point the primary planning body for the region (SIMPCO) lacks a suitable infrastructure to collect this data.

### E. Oversized Truck Loads Striking Freeway Overpasses

Interstate 29 is an important interstate freight corridor transporting large quantities of agricultural and livestock goods. As such, delays caused by oversized trailers striking bridges can have substantial economic impacts beyond the damage to the bridge and vehicle.

In 2004 there were four cases of vehicle striking overpasses in the Sioux City area. These could have been prevented by use of an alternate route or different loading of the vehicle.

### F. Improve Temporary Traffic Management Capabilities

In addition to the regular maintenance of roadways and construction of new facilities, large reconstruction efforts (for example I-29) are occasionally performed in the region. Although the State transportation authorities (SDDOT, IA DOT, NDOR) use portable traffic control devices, the City and County governments in the area do not have their own inventory and may not be able to access the devices owned by the States for traffic control.

### 3.2.3 Maintenance Related Issues

#### A. Improve Coordination for Maintenance and Deployment of Regional Information Technology Infrastructure

Various entities in the Siouxland area have already undertaken a wide variety of ITS and general Information Technology projects. However, there has not been a great deal of coordination in the roll-out of systems and their maintenance in day-to-day use. Specifically, the region could benefit from coordination in:

- Fiber optic deployment, with multiple agencies contributing to and benefiting from an integrated communications system;
- Wireless data standards could allow multiple vehicle fleets to bear the costs and share the benefits of wireless data, while extending the coverage available to all;
- Maintenance/administration coordination would improve the security and usable capacity of the Metropolitan area network as well as reduce down-time through more rapid fault detection and repair.

#### B. Improve Ability for Area Signal Systems to be Administered/Managed

There are four different city-level signal systems operated in the Siouxland area: Sioux City, North Sioux City, South Sioux City, and Sergeant Bluff. Each has developed their signals over time in response to changing traffic management needs in their respective areas. Changing technology and manufacturers over time has led to heterogeneous systems within each of the jurisdictions using different communications, programming and remote access methodologies. This has left each with difficulties in maintaining their systems at optimal efficiency.

Additionally, the use of multiple vendors' systems creates inefficiencies in maintaining the physical systems, as spare part management and replacement availability becomes an issue.

#### C. Reduce Roadway Icing Impacts

The Siouxland area has several long elevated roadway spans, notably the Gordon Drive viaduct, which spans some 4000 feet. While anti-icing procedures using a maintenance truck are effective when applied, they suffer from the disadvantage of requiring the vehicle to travel to the bridge each time conditions warrant material application.

### 3.2.4 Transit and Traveler Information Related Issues

#### A. Improve 511 System Interoperability

Each of the three States (South Dakota, Iowa, and Nebraska) have implemented a “511” telephone based traveler information service. However, in the Siouxland area, problems can arise due to the close proximity of the three jurisdictions.

Generally, an incoming traveler’s cellular call is routed to one of the three States’ systems based on the cellular base station that handles the call. However, because the call could be handled by a nearby tower that is actually in another State, the call can be routed to a 511 system that does not have the information the traveler desires.

Also, travelers frequently cross the borders between the States, but there is no mechanism to allow them to access information for the neighboring state, even though their destination may be minutes away.

#### B. Decrease Cost to Users for 511 Service/Expand Availability

As mentioned above, 511 systems are in place in all three of the States. One aspect of deploying 511 is making arrangements with telephone carriers (cellular, land line, and pay phone) to provide this service to the public and appropriately route calls.

In Iowa, an effort has been made by the State to guarantee that calls to 511 are free to users. That is, 511 calls will not be deducted from the number of minutes included in their service plans. However not all carriers have agreed to this and additional work is needed in this area.

#### C. Improve Information Collection and Distribution for Construction Events

All three States allow for easy access to construction information through their respective 511 telephone and web systems. This information is generally restricted to State-maintained roadways, and does not extend to the county or municipal level.

Also, updates to the construction information databases must be performed at CARS system workstations, which can delay information, such as changing lane closures, from being entered in a timely fashion.

#### D. Improve the Dissemination of Traveler Information

All of the State jurisdictions in the Siouxland area have moved aggressively into traveler information with 511 telephone and web services. Iowa has also deployed low power FM (LPFM) radio systems for traveler information distribution. As noted above, there has not been a mechanism put into place to allow local jurisdictions to access these dissemination mechanisms, limiting the ability of cities and counties to provide travelers with up-to-date information.

Also additional distribution mechanisms have not been used, such as informational kiosks and cable access television which could broaden the reach of traveler information services.

### 3.2.5 Integration

#### A. Improve Operational/Conditional Data Sharing Between Jurisdictions

Each of the States has implemented the CARS system for managing roadway condition data. This facilitates data sharing between areas within the state, but does not allow for data sharing between states or with local jurisdictions. While counties and cities may view condition data on the CARS-driven web sites, no mechanism is available for them to share roadway condition and construction data with the States.

## **4.0 POTENTIAL ITS SOLUTIONS**

### **4.1 Overview**

From the issues identified in Section 3, specific technical solutions were researched and reviewed with SIMPCO staff. Each solution defines the entity responsible for implementation and operation of the system, a summary of the rationale and deployment scenario envisioned, a realistic timeframe for implementation and estimated costs associated with the project. In each case, the deployment parameters are intended for comparison purposes. Timeline, costs, etc., will be determined during the design/proposal process.

### **4.2 Solutions Mapping**

Not all of the issues outlined could be addressed within the scope of this plan. Some of the issues (those highlighted in gray in Table 4) would require a separate planning process and highly specialized, non-transportation technical skills for proper treatment. The table below identifies the issues and indicates which solutions address some aspect of each.



Table 5 gives an overview of the proposed projects and estimated costs for their initial implementations, as well as the ongoing operations and maintenance costs for each. The estimates are derived from comparisons to similar projects that have been completed in other locations. However, it should be noted that ITS projects are sensitive to the specific details of the locations and infrastructures with which they must interact. For this reason, the estimates should be regarded as guidelines only at this stage. Many of the project costs involve deployments at several locations. These systems can be deployed in a phased manner as funding becomes available.

**Table 5 – Proposed ITS Project Costs**

<b>Project</b>	<b>Total Implementation Cost</b>	<b>Annual Operations and Maintenance Costs</b>
Overheight Detection	\$22,824-40,700	\$2,400-6,000
Train Detection/Warning	\$75,200	\$4,150
Coordinated Radio Communications Deployment Planning	_____	\$3,200-10,000
Coordinated MAN Deployment/Support Planning	_____	\$3,200-10,000
Overpass Anti-icing System	\$165,000-660,000	\$4,500-40,000
Slippery Condition Warning	\$13,500-55,000	\$900-3,000
Sioux City Signal Upgrades	\$22,700-85,800	\$500-1,000
Coordinated Signal Management	\$27,000-123,000	\$1,100-5,500
Regional EVP Coordination		
Vehicle Detection/Classification Improvements		
Red Light Enforcement Systems	\$0-57,500	\$0-8,000
511 Interoperability	\$0-10,000	\$0
Local/Wireless CARS Updates (MCARS)	\$0-10,000	\$0
Portable Construction Management/Traffic Control	\$362,000	\$20,250
ITS Implementation Committee	-----	Minimal

#### 4.3 Overheight Detection Sites

##### **Overview**

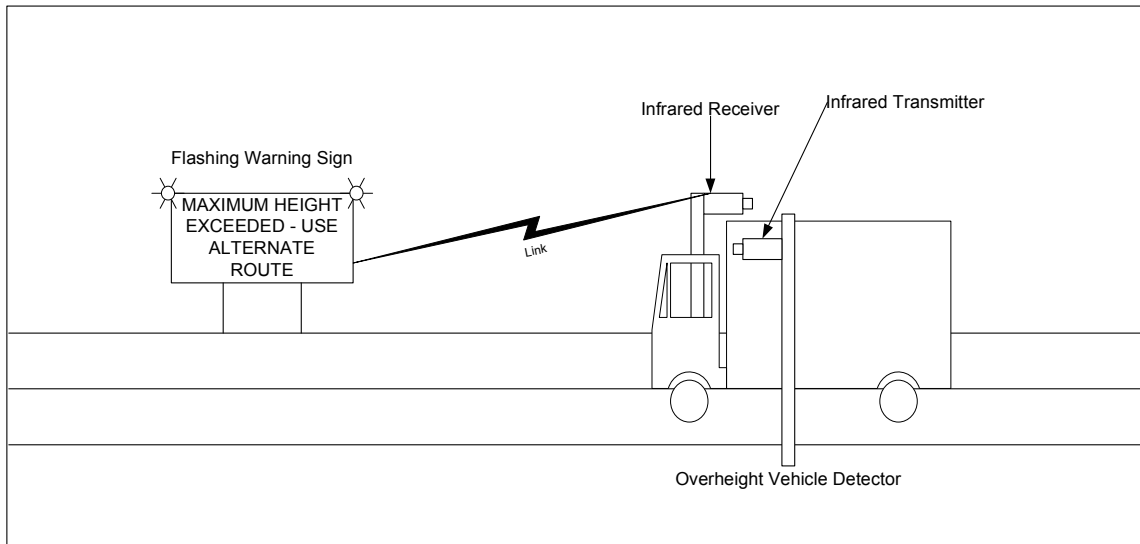
**Project Owner/Responsible Entity:** Iowa DOT, Nebraska DOR

**Project Summary:** A large commercial vehicle corridor exists in the Siouxland area, Interstate 29. On this route there are several occurrences of vehicles striking the overpass bridge structures each year. These incidents generally result from vehicles which exceed the legal height restrictions for the roadway.

Providing drivers with an indication that their loads exceed the maximum heights allowed could provide a method of avoiding these crashes. These types of systems could be deployed in a number of configurations, but will generally fall into a “mainline deployed” or “offline deployed” scenario.

A mainline deployed overheight warning system would be placed along the roadway prior to a feasible diversion point. The system measures the height of the vehicle and displays a warning to the driver to take an alternate route. An offline deployed system is used at rest areas, truck depots or other points at which large numbers of trucks pass through. For example, the rest area scenario would place the detector at the entrance to the truck parking bays. A sign indicating the maximum vehicle height for the roadway and the vehicle’s measured height is displayed to the driver, giving the opportunity to adjust the load height or plan an alternate route. Static signs can also be placed along the roadway mainline indicating the system’s availability and encouraging drivers to make use of the facility. The components of a basic overheight detection and warning system are shown below in Figure 18.

**Figure 18 – Typical Overheight Detection System Components**



**Expected Benefits**

- Fewer bridge damage crashes
- Lower repair maintenance costs for bridges
- Improved public safety
- Decreased traffic impacts resulting from road and bridge closures

**Deployment Timeframe:** 2007-2008



## Cost Estimates

<u>Device</u>	<u>Capital Cost</u>	<u>Annual Operations &amp; Maintenance</u>
Single Sensor	\$4,250	
2 Axis Mount for Sensors (2)	\$300	
Sign (static w/ flashers or VMS)	\$10,349-11,600	\$2,400-6,000
RF Link for less than 800m	\$850	
Power (existing vs. solar)	\$5,000-20,000	
	<b>Total/unit:</b>	\$2,400-6,000
Design Costs	\$2,075-3,700	
	<b>Total/project</b>	\$2,400-6,000

### 4.4 Train Detection/Warning

#### **Overview**

**Project Owner/Responsible Entity:** Iowa DOT, Nebraska DOR, City of Sioux City, City of South Sioux City

**Project Summary:** Sioux City and South Sioux City have rail corridors that pass directly through their central business district (CBD). While trains do not have very high frequencies on this facility (roughly eight per day) they can exceed 4,000 feet in length and come during a.m. and p.m. peak traffic times.

These trains create traffic delays to waiting motorists. These delays could be mitigated to an extent by encouraging traffic flow in directions parallel to the tracks by retiming traffic signals in the area. This could increase mobility to roads that have grade-separated crossings.

In addition to their traffic impacts, these trains may make it difficult for emergency response vehicles to quickly reach their destinations. Warnings of the approach of trains and their likely arrival time could be useful to both the emergency responders as they head for their destination and to travelers.

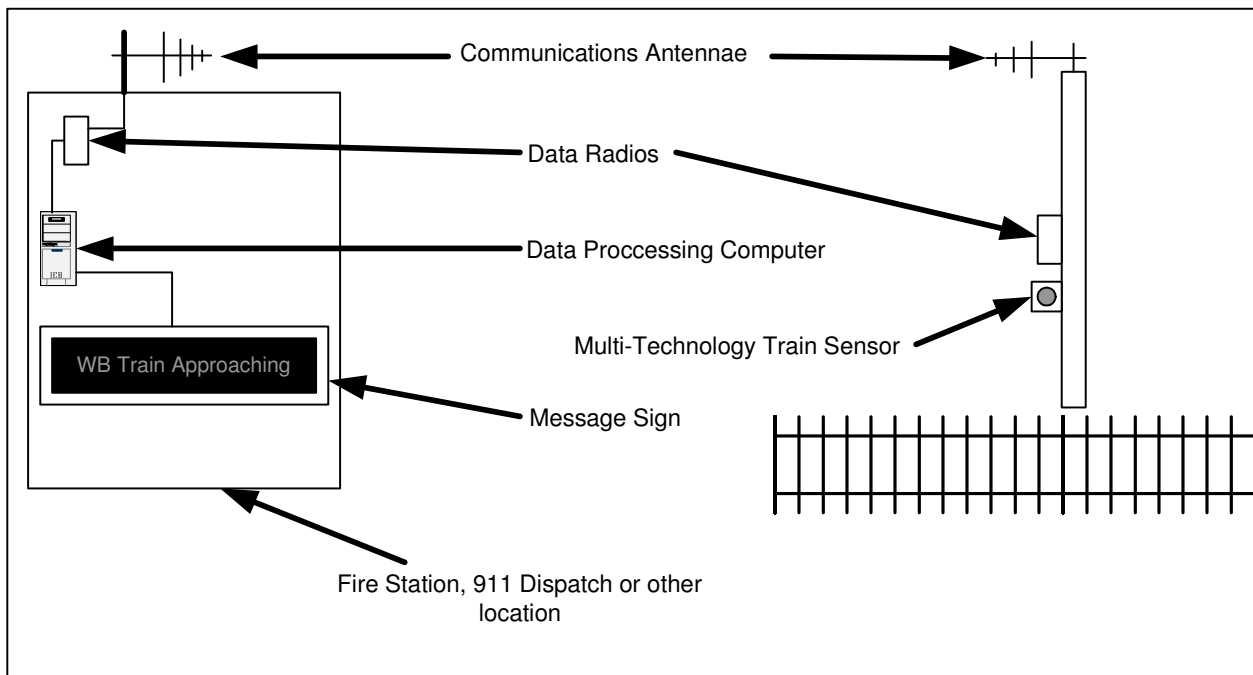
The University of Nebraska in conjunction with the Nebraska Department of Roads is conducting an evaluation of a detection and notification system in South Sioux City that uses existing “track circuits” and dynamic message signs to notify drivers of the presence of a train. This system could be expanded to provide notification to emergency responders and greater detail of information.

There are two general approaches for providing this type of information: a “smart” detection-based system, and a “passive” system that primarily relies on CCTV technology.

A smart system would be comprised of two major components, a detection system to identify an approaching train, and a display system to alert responders that a train was approaching or present. Detection can be accomplished in a number of ways: RADAR, video, in place track circuits and multi-technology detectors. The ideal detection method will depend on performance goals for the system, as well as technical and geometric concerns at the specific installation sites. Institutional issues may also be a concern if the railroad is reluctant to provide track circuit outputs or to allow placement of detectors within their ROW. For emergency responders, such as fire departments near rail crossings, small message signs would be placed in highly visible locations that could be observed as personnel depart the facility. A notification system could also be made available at the 911 dispatch centers; however, the exact nature of the system, dedicated display, on-screen message or other device, would need to be determined during design time.

The general layout of such a system is shown below in Figure 19.

**Figure 19 – Typical Train Detection System Components**



A passive solution would implement a small collection of approximately eight surveillance cameras at strategic points along the rail corridor. Locations would be chosen to maximize the warning time and continuity of train surveillance as they move through the CBDs. Either dedicated monitors or software-based displays would again be placed at the responder fire stations as well as at the 911 dispatch centers. The advanced broadband communications infrastructure in South Sioux City also makes it possible to move video displays directly to the vehicles, if desired. The video itself could be either continuous or periodic “snapshots” of the area and ideally would be transmitted digitally to maximize distribution and display options.

**Expected Benefits**

- Reduce delays by re-timing traffic signals during train blockage
- Decreased response times for emergency response.
- Fewer train-related crashes

**Deployment Timeframe:** 2006 – 2008

**Cost Estimates**

<u>Device</u>	<u>Capital Cost</u>	<u>Annual Operations &amp; Maintenance</u>
Data Radios	\$1,700	\$100
Train Detectors	\$3,000-5,200 (avg.)	\$250
Data Server Software	\$20,000-40,000	\$500
Data Server Hardware	\$3,000	\$250
Display Sign Hardware/Software	\$6,500-20,000	\$250
<b>Total/unit:</b>	\$53,400-95,700	\$1,350
Design Costs	\$10,000-20,000	
<b>Total/project</b>	\$63,700-115,700	\$1,350

4.5 Coordinated Radio Communications Deployment Planning

**Overview**

**Project Owner/Responsible Entity:** SIMPCO

**Project Summary:** The Siouxland area has moved aggressively into wireless communications systems, both the traditional licensed voice/radio public safety systems as well as the newer wireless broadband systems that have become available over the last four years. In each of these cases, the geographically compact nature of the region and the number of agencies involved make coordination desirable, both from an operations/support standpoint and from an interoperability/functionality standpoint.

There are currently several different radio systems in use for public safety purposes, spanning several frequency bands. The individual systems vary greatly in age and geographic coverage. These systems cannot communicate directly with each other and 911 dispatchers to relay messages create any cross-patches and coordinate the activity of emergency responders. The effectiveness of field personnel could be enhanced by creating the ability for individual responders to communicate in real-time with each other. Additionally, a consistent system would offer the benefits of lower on-going costs through shared support and spare-parts inventories.

Of course, there will be substantial costs involved with the actual deployment/replacement of the systems, but this project would create an overall framework for the future integration. Funding sources would then be pursued as a part of this integrated planning effort.

South Sioux City has moved forward with using an advanced Internet Protocol-based radio system that allows for very high speed packet data to be transmitted and received from moving vehicles. Although this system requires a greater number of “access points” for mobile radios to connect to than traditional VHF/UHF systems, the cost per site is relatively small. This system serves the central business district and has sufficient capacity to move full-motion video to and from vehicles.

This system could be expanded to cover a larger geographic area and into other agencies. The transit system could also be included, for example, to allow emergency transmission of the existing on-board surveillance video to dispatchers and emergency responders. System expansion should be planned on a regional level to maximize the area covered for the investment made, and for “backhaul” links to tie the access points to be connected to a larger network. System security and data access policies should also be coordinated at the regional level to insure that access is consistent with the state laws of all the affected entities and that the system is resistant to malicious attacks.

**Service Area:** SIMPCO

**Expected Benefits**

- Improved public safety
- Decreased costs for deployment
- Improved system geographic coverage
- Easier and less costly system maintenance

**Deployment Timeframe:** 2006-2010

## Cost Estimates

<u>Device</u>	<u>Capital Cost</u>	<u>Annual Operations &amp; Maintenance</u>
Staffing		\$2,000-\$4,000
Report Generation		\$1000-5,000
Support		\$200-\$1,000
<b>Total/project</b>		<b>\$3,200-\$10,000</b>

### 4.6 Coordinated MAN Deployment/Support Planning

#### **Overview**

**Project Owner/Responsible Entity:** SIMPCO

**Project Summary:** There are a variety of advanced communications technologies being used in the Siouxland area, each of which have evolved to suit their particular system owners and user needs. As systems have become more interconnected, opportunities are emerging to coordinate them to maximize the benefits of the investments made. In particular, there are two areas where coordination could be advantageous:

- 1) Fiber optic facility deployment: Fiber optic networks provide very high capacity, high reliability and high security for data transmission. Unfortunately, fiber optic cable requires careful installation and special termination techniques that make it costly. Further, since the cable is usually installed in underground conduits, cable burial can be expensive.

Because of its cost, planning and coordination between potential users is often the key to making the most of an investment. Fiber optic networks are often constructed in unconnected segments that are later interconnected into larger structures, making forward looking design critical for later integration. For example, a short fiber segment may be constructed to interconnect signal systems using a few multimode (an inexpensive fiber type) strands of fiber. Later a larger data communications network may need to lay fiber in the exact same locations to create a longer distance data link. This cost could have been avoided by simply installing a slightly more expensive hybrid fiber cable during the original construction.

Additionally, fiber “trading” is also common in the telecommunications industry. Often, cities and states are able to barter unused fiber capacity on their networks with telecommunications companies to gain access to other fiber networks at a fraction of the cost of building a new facility. An example of a public entity utilizing a private network can already be seen in South Sioux City, which uses capacity on a cable television provider’s system.

Cities, counties, and other entities (such as airports) in the region all have data communication needs which could be met most efficiently by coordinating their deployment efforts.

- 2) System maintenance and security: In addition to the fiber optic infrastructure itself, there are a wide variety of network functions that could be enhanced through regional coordination.

The devices used to connect local networks to the municipal/regional network (media converters, switches and routers with fiber interfaces, etc.) are from a variety of manufacturers purchased over a span of time as the network evolved. While this is certainly a functional solution, it can create problems with proprietary feature implementations (for example some routers support only open standards for routing network traffic, while others have their own high-performance solutions that would make them incompatible with other devices). This can create issues with system performance, maintenance, and security as a common set of security features may not be supported across the network.

A committee comprised of the stakeholders and system stewards should be formed to develop a set of standards to be phased in for data communications equipment and forward-looking planning for cooperative infrastructure deployment.

**Service Area:** SIMPCO MPO Jurisdiction

**Deployment Timeframe:** 2005-2010

**Expected Benefits**

- Improved network performance
- Improved network security
- Maximized return on infrastructure investments
- Minimized network down time
- Cost savings through shared support and facilities

**Cost Estimates**

<u>Device</u>	<u>Capital Cost</u>	<u>Annual Operations &amp; Maintenance</u>
Staffing		\$2,000-\$4,000
Report Generation		\$1000-5,000
Support		\$200-\$1,000
<b>Total/project</b>		\$3,200-\$10,000

## 4.7 Overpass Anti-icing System

### **Overview**

**Project Owner/Responsible Entity:** IDOT

**Project Summary:** Elevated roadways (bridges, overpasses, etc.) are particularly susceptible to ice formation during the winter months due to their tendency to cool more rapidly than surface roads. In Sioux City, the Gordon Drive viaduct is prone to these conditions, compromising safety for travelers.

Typically, de-icing systems consist of sensors installed in the road surface to detect the presence of ice-forming conditions, a series of storage tanks and pumps for de-icing chemicals and strategically placed nozzles to apply the chemical mixture on the roadway.

A similar system is currently in use on the US 77 bridge over the Missouri River. However, the nozzle placement has proven to be less than optimal for the area. Newer systems using fewer nozzles in a different geometry may be more suitable, particularly with regard to blockage from snow plowing.

The Gordon Drive viaduct is currently under consideration for reconstruction. An anti-icing system could either be implemented as part of that effort, or could be fitted to the existing roadway and salvaged for re-installation when reconstruction occurs.

**Service Area:** Gordon Drive viaduct.

**Deployment Timeframe:** 2006-2008

### **Expected Benefits**

- Greatly decreases the response time to treat an ice-affected roadway, versus having to deploy maintenance vehicles for the same task.
- Decreases the likelihood of an incident occurring due to ice conditions.
- Although most snowstorms will require that liquid chemicals be followed up by traditional snow removal methods, maintenance crews may find that they spend less time doing after-storm clean-up.
- The application of freeze-point reduction chemicals widens the window of opportunity to clear roads and may require less mechanical snow removal.
- Maintenance crews will have more flexibility in scheduling their responses to winter storms, resulting in less required overtime.
- External savings will be realized as a result of fewer accidents and traffic delays in the system.
- Long-term benefits will accrue because prevention and early intervention will likely result in less chemicals being used overall.

## Cost Estimates

<u>Device</u>	<u>Capital Cost</u>	<u>Annual Operations &amp; Maintenance</u>
Automatic Anti-icing System	\$75,000-300,000	\$2,250-20,000
Includes:		
Anti-icing Control System		
Equipment Shelter		
Chemical Storage Tank		
Distribution Lines		
Pump		
Nozzles		
Environmental Pavement Sensor		
Communication Equipment		
<b>Total/unit:</b>	\$75,000-300,000	\$2,250-20,000
Design Costs	\$15,000-60,000	
<b>Total/project</b>	<b>\$165,000-660,000</b>	<b>\$4,500-40,000</b>

### 4.8 Slippery Conditions Warning

#### **Overview**

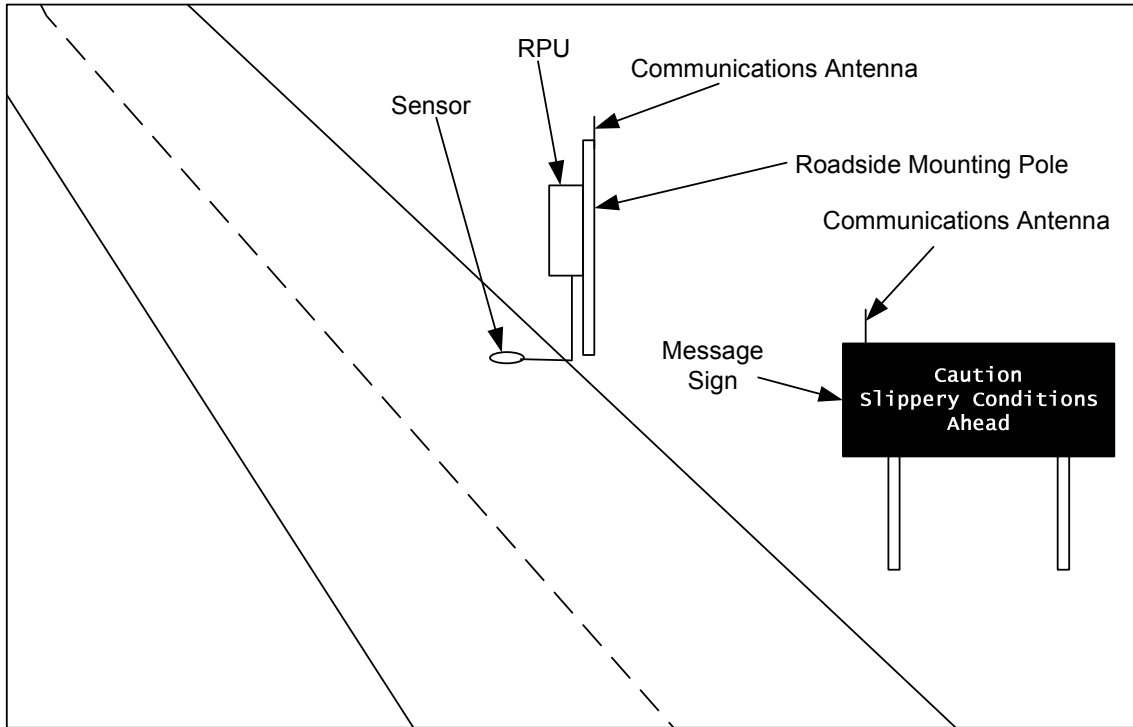
**Project Owner/Responsible Entity:** IDOT/City of Sioux City

**Project Summary:** Another approach to improving the safety of icing-prone roadways is to detect the conditions and provide a suitable warning to travelers as they approach the area. Typically this can be accomplished through the use of commercially available Road Weather Information Systems (RWIS) hardware and a simple Dynamic Message sign.

A typical installation would be comprised of an in-pavement sensor for determining pavement temperature and the presence of moisture and two message signs (one for each approaching direction). The sensor would be connected to a processing device typically called an “RPU” which the sends commands to the message signs to activate when appropriate conditions are detected. The layout of the system is shown below in Figure 20.



**Figure 20 Typical Icy Conditions Warning System Components**



The complexity of the system and the resulting costs can be adjusted based on the needs of the specific location. For example, the sign used can be a simple static sign with LED-type flashers to alert travelers or it can be a full-matrix dynamic message sign that can be used for other purposes if needed.

**Service Area:** Gordon Drive viaduct.

**Deployment Timeframe:** 2006-2007

**Expected Benefits**

- Decreased number of crashes (average cost \$61,375 per injured person in 2000 dollars according to FHWA “*The Costs of Highway Crashes*”, 1991)

**Cost Estimates**

<u>Device</u>	<u>Capital Cost</u>	<u>Annual Operations &amp; Maintenance</u>
RPU/Sensor	\$5,000-10,000	\$500-2,000
Communication Equipment	\$1,500-3000	\$200-500
Roadside Sign	\$2,000-20,000	\$200-500
<b>Total/unit:</b>	\$8,500-33,000	\$900-3,000
Design Costs	\$5,000-20,000	
<b>Total/project</b>	<b>\$13,500-55,000</b>	<b>\$900-3,000</b>

## 4.9 Sioux City Signal Upgrades

### **Overview**

**Project Owner/Responsible Entity:** City of Sioux City, South Sioux City

**Project Summary:** The City of Sioux City is the largest operator of traffic signals in the Siouxland Area with 137 signalized intersections. These systems have evolved over time, with several different manufacturers' equipment being used concurrently.

The diversity of equipment has begun to create issues for operations and maintenance, with several different stocks of spare parts being necessary and multiple control interfaces needed to allow for system operation. The age of equipment is also making replacement parts increasingly scarce, with some items no longer available at all.

The City has already moved to advanced signal controllers at new intersections, including such technologies as machine-vision vehicle detectors. An organized migration to these newer systems is advisable as failures of parts of the older systems could render a portion of the signal system inoperable.

South Sioux City has already completed an improvement plan as of March 2003. This plan recommends that controller and signal interconnection upgrades be completed similar to those suggested above. As a part of a regional effort, action should be taken on the plan recommendations.

**Service Area:** City of Sioux City, South Sioux City

**Deployment Timeframe:** 2006-2015

### **Expected Benefits**

- Improved system reliability
- Decreased staff costs
- Improved traffic management/decreased congestion through better signal coordination

### **Cost Estimates \***

<u>Device</u>	<u>Capital Cost</u>	<u>Annual Operations &amp; Maintenance</u>
Signal Cabinet (ea)	\$12,500-16,000	\$0-100
Signal Controller (ea)	\$2,500-6,000	\$200-400
Signal Interconnect	\$3,000-56,000	\$300-600
<b>Total/unit:</b>	\$18,000-78,000	\$500-1,000
Design Costs	\$4,700-7,800	
<b>Total/project</b>	<b>\$22,700-85,800</b>	<b>\$500-1,000</b>

\*This cost estimate is per controller. A total of 124 controllers may eventually be upgraded

#### 4.10 Coordinated Signal Management

##### **Overview**

**Project Owner/Responsible Entity:** SIMPCO, City of Sioux City, City of South Sioux City, City of Sergeant Bluff, City of North Sioux City

**Project Summary:** As mentioned above, Sioux City operates the largest signal system in the region, however three other jurisdictions operate signals in the MPO. Each of these systems shares some operational characteristics and hardware types with the others.

City of Sioux City staff currently provides some traffic engineering and system operation support to the surrounding communities on an as needed basis. As part of a regional approach to traffic management, the systems could be treated as part of an integrated traffic management solution.

This approach would require a cooperative planning effort between the cities to address hardware upgrades throughout the system. Several specific needs have been identified in the South Sioux City area as part of a previous signal systems study and in Sioux City as part of the “Traffic Signal Systems Evaluation” completed by H.R. Green and Iteris. It may be advantageous for coordination of any resulting action at the MPO level to produce as much commonality between the signal systems as possible.

Once sufficiently compatible systems are in place, a system management software package could then be implemented (ICONS, Aries, and VTOC are examples of these) that would allow both distributed monitoring and central management of the resulting system. Such a solution would leverage the engineering expertise from Sioux City and provide maintenance/operations personnel with improved tools to maintain and adjust system parameters using a minimum of staff time.

**Service Area:** SIMPCO MPO

**Deployment Timeframe:** 2006-2015

##### **Expected Benefits**

- Decreased system operating costs
- Decreased congestion

## Cost Estimates

<u>Device</u>	<u>Capital Cost</u>	<u>Annual Operations &amp; Maintenance</u>
System Management Software	\$20,000-\$100,000	\$1,000-5,000
Application Servers	\$2,000-\$8,000	\$100-\$500
	<b>Total/unit:</b>	\$1,100-\$5,500
Design Costs	\$5,000-\$15,000	
	<b>Total/project</b>	\$1,100-\$5,500

### 4.11 Regional EVP Coordination

#### **Overview**

**Project Owner/Responsible Entity:** City of Sioux City and South Sioux City (in conjunction with IDOT and NDOR, where appropriate)

**Project Summary:** The use of EVP (systems that allow emergency vehicles to “preempt” or get on-demand green lights at intersections) has proven successful in the Sioux City area. These systems enjoy broad support among emergency responders and a system expansion is desired. The current technology for EVP is the optically actuated 3M Opticom system, which offers broad flexibility in how the system is used both for preemption and priority signal timing plans.

Several corridors have been identified as promising candidates for the near term. These are shown on the map in Figure 21.

**Service Area:** Sioux City/South Sioux City

**Deployment Timeframe:** 2004-2008

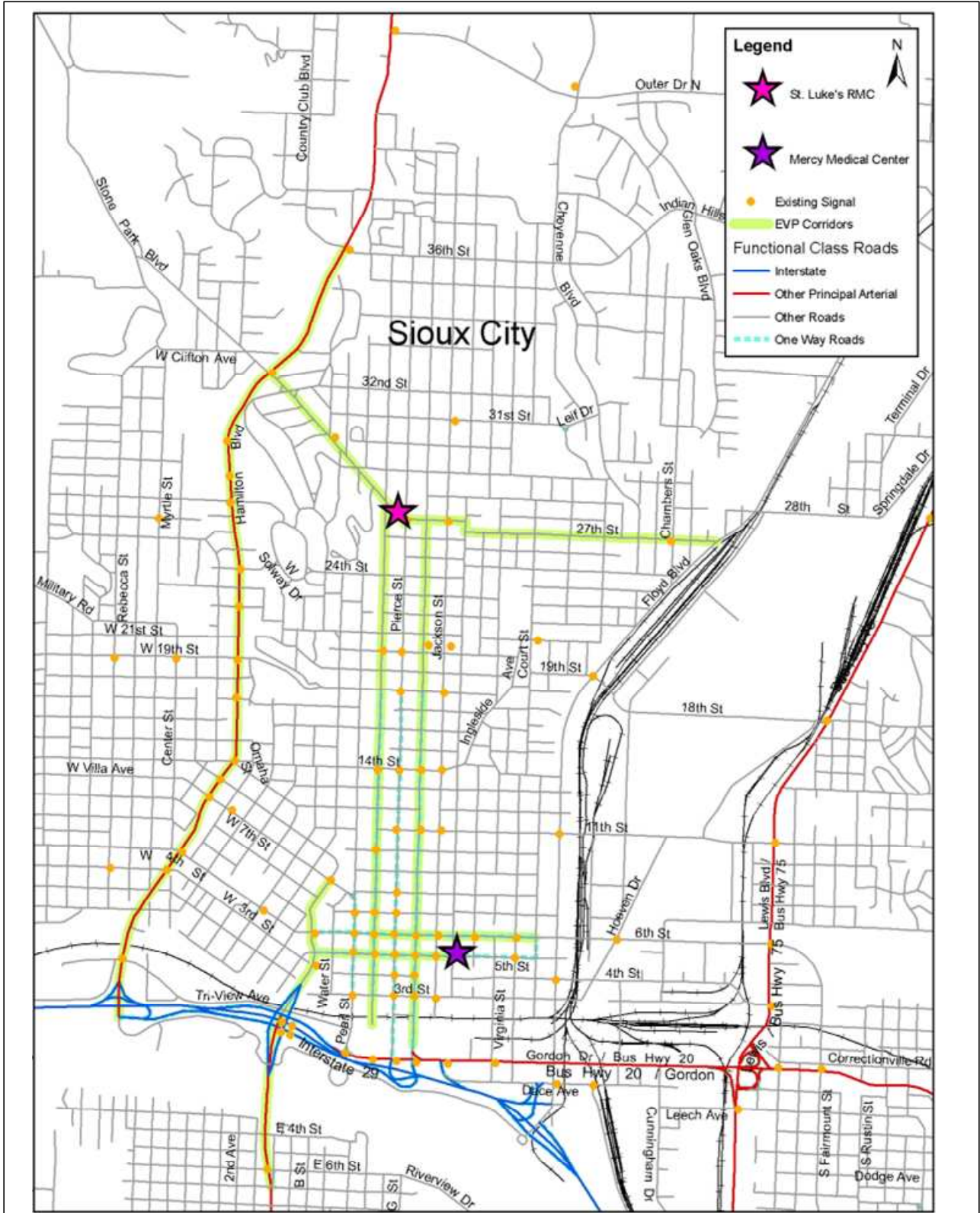


Figure 21  
EVP Priority Corridors

## 4.12 Vehicle Detection/Classification Improvements

### **Overview**

**Project Owner/Responsible Entity:** IDOT, SIMPCO, Cities in the region

**Project Summary:** SIMPCO has responsibility for a variety of transportation planning functions for the region, and therefore has a range of data collection needs. One of the most important tools in the transportation planning process is the travel demand forecasting model, which gives planners an idea of the traffic levels on roadways at a point in the future. Based on this information, land use and transportation improvement plans can be put in place to accommodate future demands.

The viability of the forecasting model is closely tied to the quality of data used for model calibration – the process of adjusting the model so that it accurately current conditions given present day inputs. Accurate counts of vehicles on roadways and their classifications (automobile, bus, tractor-trailer, etc.) is the key to proper model calibration.

The current methods of obtaining this information – spot visual counts and temporary installations of automatic traffic recorders – provide only basic information. These methods provide only basic “axle” counts as vehicles roll over pneumatic tubes or are subject to human error. Additional count data could be obtained through signal system enhancements using video detection systems already in use on a limited number of intersections in Sioux City. This approach would make use of signal system hardware and requires that a method of retrieving the data and transmitting it to SIMPCO be developed.

Small, portable non-intrusive detectors can also be used to count and classify vehicles on a spot basis when a permanent installation is not cost-effective.

An initial deployment of this approach may use a sample of four representative intersections to be outfitted with video detection systems and a single non-intrusive collection kit purchased.

**Service Area:** SIMPCO MPO

**Deployment Timeframe:** 2005-2010

### **Expected Benefits**

- Decreased data collection staff costs
- Improved data accuracy
- Improved planning results and better transportation investment management

## Cost Estimates

<u>Device</u>	<u>Capital Cost</u>	<u>Annual Operations &amp; Maintenance</u>
Video Detection Upgrades	\$8,000-10,000 ea.	\$500-1,000
Portable Non-intrusive System	\$6,000-10,000 ea.	\$500-1,000
	<b>Total/unit:</b>	\$1,000-2,000
Design Costs		
	<b>Total/project</b>	\$1,000-2,000
	To be determined based on number of intersections	

### 4.13 Red Light Enforcement Systems

#### **Overview**

**Project Owner/Responsible Entity:** City of Sioux City (Police Department)

**Project Summary:** Red light violations are a significant factor in approximately 260,000 crashes in the United States every year. A study completed in January of 2001 analyzed the impacts of red light running in the state of Iowa, and identified the intersection of U.S. 75 and 18<sup>th</sup> Street as having roughly 5.2 violations per 1000 vehicles using the intersection or 2.2 violations per hour.

One method of addressing the violation problem is the use of automated red-light enforcement systems. These usually consist of a camera to record the vehicle's license plate number, one or more cameras to determine if the vehicle is in violation, and an interface to the local signal controller to determine when a red light is being displayed. Once a violation is detected, the owner of the vehicle can be sent a traffic citation or simply a warning by mail.

An evaluation deployment could be made at this intersection in cooperation with one of several system providers. If citations are to be issued and fines collected, the system may be provided without hardware or operations costs. This option would need clarification with Iowa legislation to be certain it is operating legally. If a warning is to be sent instead of a violation, the system would most likely need to be purchased by the Sioux City, as there would not be a revenue sharing opportunity.

**Service Area:** Intersection of U.S. 75 and 18<sup>th</sup> Street in Sioux City

**Deployment Timeframe:** 2007-2008

#### **Expected Benefits**

- Decrease number of crashes/Improve public safety

## Cost Estimates

<u>Device</u>	<u>Capital Cost</u>	<u>Annual Operations &amp; Maintenance</u>
Automated Violation System	0-\$50,000	\$0-\$2,000
Violator Notifications		\$0-\$6,000
	<b>Total/unit:</b>	\$0-\$8,000
Design Costs	\$0-\$7,500	
	<b>Total/project</b>	\$0-\$8,000

### 4.14 511 Interoperability

#### **Overview**

**Project Owner/Responsible Entity:** IDOT, SDDOT, NDOR

**Project Summary:** The Siouxland area is unusual in the fact that the MPO overlaps three state jurisdictions: Iowa, South Dakota, and Nebraska. Each of these states has implemented a 511 telephone-based traveler information system to assist travelers with weather and construction data.

A unique problem exists with this service in the SIMPCO area, however: the close proximity of cities in each of the states results in calls being directed to the wrong state's system for cell phone users as their calls may be picked up by a tower in a neighboring state. Also, since many trips may begin in one jurisdiction and end in another, the traveler may need information from the neighboring State's system, but there will be no means of accessing it.

A simple approach for resolving these issues would be to put a "front-end" menu choice for the caller that allows them to select the appropriate State's system for their needs.

This customization would be carried out by the CARS/511 system operator, Castle Rock Consultants, and would require agreement from all three States for the wording of the message.

**Service Area:** Regionwide for the states of Iowa, South Dakota, and Nebraska

**Deployment Timeframe:** 2005-2006

#### **Expected Benefits**

- Improve traveler information



## Cost Estimates

<u>Device</u>	<u>Capital Cost</u>	<u>Annual Operations &amp; Maintenance</u>
511 menu customization	0-\$10,000	\$0
	<b>Total/unit:</b>	\$0
Design Costs		
	<b>Total/project</b>	\$0

### 4.15 Local/Wireless CARS Updates (MCARS)

#### **Overview**

**Project Owner/Responsible Entity:** IDOT, SDDOT, NDOR (as desired)

**Project Summary:** The Condition Acquisition and Reporting System (CARS) is the basis for the 511 traveler information system and is becoming a de facto clearing house for construction information and travel-related weather conditions.

This system has two limitations that affect both the traveler and the system operators (DOTs/DOR): the information has to be entered from a workstation attached to the system, resulting in delays in updating information, and; only state roads and interstates are available for condition reporting, leaving out many roads that travelers may be interested in.

The first limitation can be addressed through implementing the MCARS or Mobile CARS system created by Castle Rock Consultants that provides a cell phone/PDA interface to the CARS database. This allows updates to be made directly from the roadway for such items as lane closures and plowing status that may change frequently during the day.

The second, geographic, limitation

**Service Area:** SIMPCO MPO initially, extendable to other jurisdictions

**Deployment Timeframe:** 2006-2007

#### **Expected Benefits**

- Decrease number of crashes/Improve public safety
- Decrease traveler delays

## Cost Estimates

<u>Device</u>	<u>Capital Cost</u>	<u>Annual Operations &amp; Maintenance</u>
Enable MCARS	\$50-\$15,000	\$0
Enhance database	\$20,000-50,000	
<b>Total/project</b>	<hr/> \$25,000-65,000	<hr/> \$0

### 4.16 Portable Construction Management/Traffic Control

#### **Overview**

**Project Owner/Responsible Entity:** SDDOT, IDOT, NDOR

**Project Summary:** To better manage special event and seasonal traffic, a constellation of portable Dynamic Message Signs (DMS) and vehicle detection equipment would be deployed to supplement the planned DMS system. Managing

Initially, enough portable DMS would be procured to supplement the proposed DMS Sites in the Sioux City area. The future sites are shown in Figure 22.

Additionally, equipping a subset of these sites with vehicle detection hardware would allow for the monitoring of traffic flow in the area. Flow information could then be used for traffic management purposes as well as for emergency response routing.

The signs could communicate wirelessly over the existing wireless Ethernet network used by the City, and would be controllable from multiple host locations.

Signs should also be evaluated to determine if a fixed installation may be better suited for the specific locations. A high volume of traffic at a particular location, frequent use of the sign to display messages or difficulty in setting up a portable sign may make a fixed sign more desirable.

To ensure consistent messages are displayed to the public, a manual of operations covering not only use in the Sioux City area but also for signs located statewide should be developed. This manual should define the following:

- The criteria that must be met to display a message
- Types of messages that will be permitted to be displayed (advisory, special event, etc.)
- Prohibited message types
- Permitted applications for signs (emergency management, traffic management, etc.)
- Operational responsibility and authority
- Timing of message display/deactivation
- Sign system priorities/precedence
- Message content/wording/approved message sets

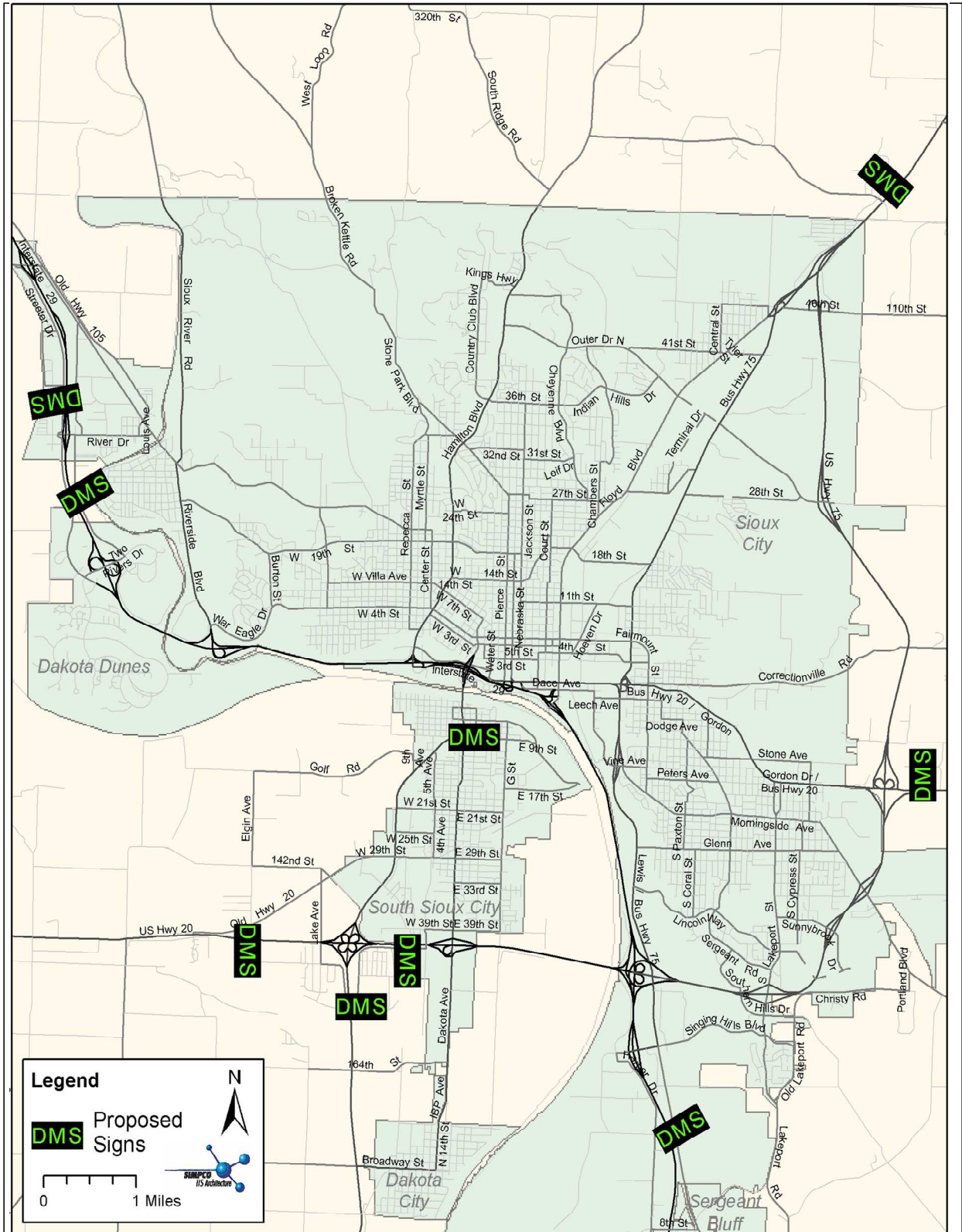


Figure 22  
Permanent DMS Deployment Sites

**Service Area:** SIMCO MPO

**Deployment Timeframe:** Initial deployment Spring 2004, 12-24 months for complete deployment

### **Expected Benefits**

The US DOT's ITS JPO has collected information on the impact of ITS for the past ten years; the result is an ITS benefit database. The following are a subset of those benefits that pertain to DMS.

- In Philadelphia, 86 percent of surveyed commuters changed their route as a result of real-time traveler information.
- In Idaho, weather-related warnings on freeway dynamic message signs decreased vehicle speeds 35 percent, compared to a 9 percent decrease without the signs.
- IDAS models of ARTIMIS in Cincinnati and Northern Kentucky indicated traveler information may have reduced fatalities by 3.2 percent.
- In the DC metro area, a simulation model showed that commuters who used traveler information may improve their on-time reliability 5-16 percent.

### **Cost Estimates**

<u>Item</u>	<u>Capital Cost</u>	<u>Annual Operations &amp; Maintenance</u>
DMS – portable	\$25,000	\$1,500
Communication Equipment	\$1,500	\$200
Detection	\$7,000	\$300
Control Workstation	\$2,500 (per license)	\$50
<b>Total/unit:</b>	\$33,500 (with detection)	\$2,000 (with detection)
	\$26,500 (without detection)	\$1,700 (without detection)
System Design Costs	\$20,000	
<b>Total/project</b>	<b>\$46,000-53,500 ea.</b>	<b>\$1,700-2,000</b>

#### 4.17 ITS Implementation Committee

##### **Overview**

**Project Owner/Responsible Entity:** SIMPCO

**Project Summary:** To guide and coordinate the program of ITS projects as they are deployed over the next five to eleven years, a standing committee of stakeholders should be established to facilitate a free flow of information between affected parties. Ideally, the committee would incorporate input from all the entities involved in the preparation of the ITS Integration Strategy and would be inclusive of all of the concerns expressed.

Members of the committee would be determined by the existing MPO committees, as well as input from other (State, Federal) jurisdictions. This committee would meet a minimum of six times per year, and as often as needed by specific project deployments.

This committee would also be in a position to assume responsibilities for maintaining the Regional ITS Architecture developed as a part of this plan. The Architecture documents should be updated as each project is deployed or as an underlying system is changed. Proper training in the National ITS Architecture format and the Turbo Architecture tools will be required for staff who will work with the Regional Architecture documentation.

**Service Area:** SIMPCO

**Deployment Timeframe:** 2005-2015

**Expected Benefits**

- Cost savings through cooperation with other projects
- Minimized deployment construction conflicts

**Cost Estimates**

Minimal

## 5.0 DEPLOYMENT SCHEDULE

This section lists all of the proposed projects and a general list of tasks necessary to complete them. Each task has an approximate start date and duration in days the durations have been estimated from experience with comparable projects.

Many factors will affect the deployments of the recommended projects, including the availability of funds, prioritization of goals in the region and the status of supporting systems. The ITS Implementation Committee should, as part of its charge, coordinate these factors and adjust the schedule presented here as necessary.

All of the project timelines represented in this section are subject to inclusion in the Transportation Improvement Program (TIP). Inclusion in the TIP will affect the timing and order of proposed projects.

The following page presents graphically the schedule for deployment. The larger black bars represent the overall duration for project completion; the lighter gray bars indicate the duration for specific phases or subtasks in the project. All time should be considered as estimates, as specific design decisions made during project deployment may affect the time needed to accomplish a given task.

ID	Task Name	2005				2006				2007				2008				2009				2010				2011				2012				2013				2014			
		Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4				
1	Overheight Detection																																								
2	Train Detection/Warning																																								
3	Coordinated Radio Communications Deployment Planning																																								
4	Coordinated MAN Deployment/Support Planning																																								
5	Overpass Anti-icing System																																								
6	Slippery Condition Warning																																								
7	Sioux City Signal Upgrades																																								
8	Coordinated Signal Management																																								
9	Regional EVP Coordination																																								
10	Vehicle Detection/Classification Improvements																																								
11	Red Light Enforcement Systems																																								
12	511 Interoperability																																								
13	Local/Wireless CARS Updates (MCARS)																																								
14	Portable Construction Management/Traffic Control																																								
15	ITS Implementation Committee																																								

Project: Project1 Date: Wed 3/9/05	Task Split	Progress Milestone	Summary Project Summary	External Tasks External Milestone	Deadline
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Page 1

## 6.0 Measures of Effectiveness

### 6.1 Overview

An important component of an ITS project deployment is identifying a suitable method for measuring the system benefits. In this report, Measures of Effectiveness (MOEs) are developed where appropriate for each of the proposed ITS projects. These measures provide a starting point for further evaluating the effectiveness of each project. The development of this data provides a valuable method for prioritizing deployments and optimizing resource expenditures.

The MOEs developed in this document provide a picture of the types of data that should be collected in the evaluation of each system. Notice that some of the data should be collected in the “before” or “without” condition prior to system deployment and/or turn on. Measures may be objective (directly measurable) or subjective (determined by survey responses or other qualitative mechanisms). For each project, the measures are listed, along with the data element and a likely source for the data.

The performance information provided in this report serves as a starting point for conducting a more formal evaluation. However, in order to successfully measure system performance, it is important to develop a detailed *Evaluation Test Plan* that will guide the evaluation effort. Formal evaluations provide a reasoned consideration of how well project goals and objectives were achieved. Evaluation test plans provide testable hypotheses and should be conducted by independent third parties. Evaluations should begin as soon as possible in project development because they can instigate changes that will allow projects to meet or exceed their goals and objectives.

The FHWA has developed detailed evaluation guidelines that provide a valuable starting point for project evaluations. These guidelines include the following Measures of Effectiveness within five standard Goal Areas:

<u>Goal Area</u>	<u>Measure</u>
<b>1. Safety</b>	Reduction in the overall rate of crashes Reduction in the rate of crashes resulting in fatalities Reduction in the rate of crashes resulting in injuries Improvement in surrogate measures
<b>2. Mobility</b>	Reduction in delay Reduction in travel time variability Improvement in customer satisfaction
<b>3. Efficiency</b>	Increases in freeway and arterial throughput or effective capacity
<b>4. Productivity</b>	Cost savings
<b>5. Energy and the Environment</b>	Decrease in emission levels Decrease in energy consumption



Some specific evaluation criteria are listed below. These criteria are applied to the specific ITS projects in the section that follows.

### **Quantitative Evaluation Measures**

- Traffic volume
- Average travel time
- Average delay
- Number of stops
- Queue length
- System performance (does the system meet requirements)
- Crash rates
- Cost (includes labor and materials for the following)
  - Procurement cost
  - Deployment cost
  - Operations cost
  - Maintenance cost

### **Qualitative Evaluation Measures**

- Reliability
- Maintainability
- Ease of use
- Owner's perception of value/effectiveness
- Customer's perception of value/effectiveness
- Institutional issues
- Technical issues
  - Hardware
  - Software
  - Communication
  - Expandability

***Institutional issues*** should not be overlooked in ITS evaluations. Institutional issues can be the most challenging aspect of a project, often exceeding the challenges posed by technical issues. The following institutional issues may apply to some or all of the projects that will be deployed:

- Jurisdictional boundaries
- Liability

- Staff turnover
- Funding
- Maintenance responsibility

**Customer Satisfaction** measures the difference between users’ expectations and users’ experience in relation to the service being provided. A customer satisfaction survey should evaluate whether the project delivers sufficient value (or benefits) for the customer’s investment of money or time. Since ITS projects are usually developed to serve the public, it is important to ensure that public needs are being met. The following six elements of a customer’s experience can be assessed:

- Product awareness
- Expectations of product benefits
- Product use
- Response – decision-making and/or behavior change
- Realization of benefits
- Assessment of value

The source of data for several of these items is best collected with attitude surveys and/or interviews of project participants. Surveys can be configured to allow responders to give a variable score to qualitative questions. For example, a question could ask to rate the ease of system use on a scale of one to five. Data obtained in these ways are useful for drawing conclusions from numerous responses.

## 6.2 Measures of Effectiveness by Project

### 6.2.1 Overheight Detection

#### Quantitative Evaluation Criteria

Objective	MOE	Data Source
Quantify change in crash rates	Crashes per VMT	Crash statistics
Determine if system meets requirements	Performance test results	System test data
Quantify system costs (including equipment and labor)	Procurement cost	Procurement list
	Deployment cost	Bid documents
	Operations cost	Survey/logs
	Maintenance cost	Survey/logs

#### Qualitative Evaluation Criteria

<b>MOE</b>	<b>Data Source</b>
Reliability	Survey/logs
Maintainability	Survey/logs
Ease of use	Survey/interview
Owner's perception of value/effectiveness	Survey/interview
Customer perception of value/effectiveness	Survey/interview
Institutional issues	Survey/interview
Technical issues	Survey/interview

## 6.2.2 Train Detection/Warning

### Quantitative Evaluation Criteria

<b>Objective</b>	<b>MOE</b>	<b>Data Source</b>
Quantify change in highway/rail intersection crash rates	Crashes per VMT	Crash statistics
Quantify emergency vehicle response time	Average response time	Staff logs
Quantify vehicle delays along rail corridor	Average intersection delay	Intersection observations
Quantify vehicle travel time along rail corridor	Travel time	Floating car travel time runs
Determine if system meets requirements	Performance test results	System test data
Quantify system costs (including equipment and labor)	Procurement cost	Procurement list
	Deployment cost	Bid documents
	Operations cost	Survey/logs
	Maintenance cost	Survey/logs

### Qualitative Evaluation Criteria

<b>MOE</b>	<b>Data Source</b>
Reliability	Survey/logs
Maintainability	Survey/logs
Ease of use	Survey/interview
Owner's perception of value/effectiveness	Survey/interview
Customer perception of value/effectiveness	Survey/interview
Institutional issues	Survey/interview
Technical issues	Survey/interview

## 6.2.3 Coordinated Radio Communications Deployment Planning

### Quantitative Evaluation Criteria

<b>Objective</b>	<b>MOE</b>	<b>Data Source</b>
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Quantify geographic coverage	Performance test results	System test data
Determine if system meets requirements	Performance test results	System test data
Quantify system costs (including equipment and labor)	Procurement cost	Procurement list
	Deployment cost	Bid documents
	Operations cost	Survey/logs
	Maintenance cost	Survey/logs

### Qualitative Evaluation Criteria

MOE	Data Source
Reliability	Survey/logs
Maintainability	Survey/logs
Ease of use	Survey/interview
Owner's perception of value/effectiveness	Survey/interview
Customer perception of value/effectiveness	Survey/interview
Institutional issues	Survey/interview
Technical issues	Survey/interview

## 6.2.4 Coordinated MAN Deployment/Support Planning

### Quantitative Evaluation Criteria

Objective	MOE	Data Source
Determine if system meets requirements	Performance test results	System test data
Quantify system costs (including equipment and labor)	Procurement cost	Procurement list
	Deployment cost	Bid documents
	Operations cost	Survey/logs
	Maintenance cost	Survey/logs

### Qualitative Evaluation Criteria

MOE	Data Source
Reliability	Survey/logs
Maintainability	Survey/logs
Ease of use	Survey/interview
Owner's perception of value/effectiveness	Survey/interview
Customer perception of value/effectiveness	Survey/interview
Institutional issues	Survey/interview
Technical issues	Survey/interview

## 6.2.5 Overpass Anti-icing System

### Quantitative Evaluation Criteria

Objective	MOE	Data Source
Quantify reduction in icy conditions	Hours roadways are icy	Archived system data
Quantify change in crash rates	Crashes per VMT	Crash statistics
Determine if system meets requirements	Performance test results	System test data
Quantify cost savings due to reduced maintenance vehicle responses	Time/material costs for vehicle response	Archived system data Historical data
Quantify system costs (including equipment and labor)	Procurement cost	Procurement list
	Deployment cost	Bid documents
	Operations cost	Survey/logs
	Maintenance cost	Survey/logs

### Qualitative Evaluation Criteria

MOE	Data Source
Reliability	Survey/logs
Maintainability	Survey/logs
Ease of use	Survey/interview
Owner's perception of value/effectiveness	Survey/interview
Customer perception of value/effectiveness	Survey/interview
Institutional issues	Survey/interview
Technical issues	Survey/interview

## 6.2.6 Slippery Conditions Warning

### Quantitative Evaluation Criteria

Objective	MOE	Data Source
Quantify change in vehicle speeds	Average speed	Detector station (radar detector/loops/road tubes)
Quantify change in crash rates	Crashes per VMT	Crash statistics
Determine if system meets requirements	Performance test results	System test data
Quantify system costs (including equipment and labor)	Procurement cost	Procurement list
	Deployment cost	Bid documents
	Operations cost	Survey/logs
	Maintenance cost	Survey/logs

### Qualitative Evaluation Criteria

<b>MOE</b>	<b>Data Source</b>
Reliability	Survey/logs
Maintainability	Survey/logs
Ease of use	Survey/interview
Owner's perception of value/effectiveness	Survey/interview
Customer perception of value/effectiveness	Survey/interview
Institutional issues	Survey/interview
Technical issues	Survey/interview

## 6.2.7 Sioux City Signal Upgrades

### Quantitative Evaluation Criteria

<b>Objective</b>	<b>MOE</b>	<b>Data Source</b>
Quantify vehicle delays along signalized corridors	Average intersection delay	Intersection observations
Quantify vehicle travel time along signalized corridor	Travel time	Floating car travel time runs
Determine if system meets requirements	Performance test results	System test data
Quantify system costs (including equipment and labor)	Procurement cost	Procurement list
	Deployment cost	Bid documents
	Operations cost	Survey/logs
	Maintenance cost	Survey/logs

### Qualitative Evaluation Criteria

<b>MOE</b>	<b>Data Source</b>
Reliability	Survey/logs
Maintainability	Survey/logs
Ease of use	Survey/interview
Owner's perception of value/effectiveness	Survey/interview
Customer perception of value/effectiveness	Survey/interview
Institutional issues	Survey/interview
Technical issues	Survey/interview

## 6.2.8 Coordinated Signal Management

### Quantitative Evaluation Criteria

<b>Objective</b>	<b>MOE</b>	<b>Data Source</b>
Quantify vehicle delays along signalized corridors	Average intersection delay	Intersection observations
Quantify vehicle travel time along signalized corridor	Travel time	Floating car travel time runs
Determine if system meets requirements	Performance test results	System test data

Quantify system costs (including equipment and labor)	Procurement cost	Procurement list
	Deployment cost	Bid documents
	Operations cost	Survey/logs
	Maintenance cost	Survey/logs

### Qualitative Evaluation Criteria

MOE	Data Source
Reliability	Survey/logs
Maintainability	Survey/logs
Ease of use	Survey/interview
Owner's perception of value/effectiveness	Survey/interview
Customer perception of value/effectiveness	Survey/interview
Institutional issues	Survey/interview
Technical issues	Survey/interview

## 6.2.9 Regional EVP Coordination

### Quantitative Evaluation Criteria

Objective	MOE	Data Source
Quantify emergency vehicle response time	Average response time	Staff logs
Quantify change in crash rates involving emergency vehicles	Crash rates	Crash data
Determine if system meets requirements	Performance test results	System test data
Quantify system costs (including equipment and labor)	Procurement cost	Procurement list
	Deployment cost	Bid documents
	Operations cost	Survey/logs
	Maintenance cost	Survey/logs

### Qualitative Evaluation Criteria

MOE	Data Source
Reliability	Survey/logs
Maintainability	Survey/logs
Ease of use	Survey/interview
Owner's perception of value/effectiveness	Survey/interview
Customer perception of value/effectiveness	Survey/interview
Institutional issues	Survey/interview
Technical issues	Survey/interview

## 6.2.10 Vehicle Detection/Classification Improvements

### Quantitative Evaluation Criteria

Objective	MOE	Data Source
Determine if system meets requirements (includes detection accuracy)	Performance test results	System test data
Quantify system costs (including equipment and labor)	Procurement cost	Procurement list
	Deployment cost	Bid documents
	Operations cost	Survey/logs
	Maintenance cost	Survey/logs

### Qualitative Evaluation Criteria

MOE	Data Source
Reliability	Survey/logs
Maintainability	Survey/logs
Ease of use	Survey/interview
Owner's perception of value/effectiveness	Survey/interview
Customer perception of value/effectiveness	Survey/interview
Institutional issues	Survey/interview
Technical issues	Survey/interview

## 6.2.11 Red Light Enforcement System

### Quantitative Evaluation Criteria

Objective	MOE	Data Source
Quantify rate of red light running	Red light violations per VMT	System data
Quantify change in crash rates	Crashes per VMT	Crash statistics
Determine if system meets requirements	Performance test results	System test data
Quantify system costs (including equipment and labor)	Procurement cost	Procurement list
	Deployment cost	Bid documents
	Operations cost	Survey/logs
	Maintenance cost	Survey/logs

### Qualitative Evaluation Criteria

MOE	Data Source
Reliability	Survey/logs
Maintainability	Survey/logs
Ease of use	Survey/interview
Owner's perception of value/effectiveness	Survey/interview
Customer perception of value/effectiveness	Survey/interview
Institutional issues	Survey/interview



Technical issues	Survey/interview
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## 6.2.12 511 Interoperability

### Quantitative Evaluation Criteria

Objective	MOE	Data Source
Determine if system meets requirements	Performance test results	System test data
Quantify system costs (including equipment and labor)	Procurement cost	Procurement list
	Deployment cost	Bid documents
	Operations cost	Survey/logs
	Maintenance cost	Survey/logs

### Qualitative Evaluation Criteria

MOE	Data Source
Reliability	Survey/logs
Maintainability	Survey/logs
Ease of use	Survey/interview
Owner's perception of value/effectiveness	Survey/interview
Customer perception of value/effectiveness	Survey/interview
Institutional issues	Survey/interview
Technical issues	Survey/interview

## 6.2.13 Local/Wireless CARS Updates (MCARS)

### Quantitative Evaluation Criteria

Objective	MOE	Data Source
Determine if system meets requirements	Performance test results	System test data
Quantify system costs (including equipment and labor)	Procurement cost	Procurement list
	Deployment cost	Bid documents
	Operations cost	Survey/logs
	Maintenance cost	Survey/logs

### Qualitative Evaluation Criteria

MOE	Data Source
Reliability	Survey/logs
Maintainability	Survey/logs
Ease of use	Survey/interview
Owner's perception of value/effectiveness	Survey/interview
Customer perception of value/effectiveness	Survey/interview
Institutional issues	Survey/interview
Technical issues	Survey/interview

## 6.2.14

## Portable Construction Management/Traffic Control

### Quantitative Evaluation Criteria

Objective	MOE	Data Source
Quantify traffic using alternate routes when DMS used	Network traffic volume (vehicles/hour)	Detector station (radar detector/loops/road tubes)
Quantify change in vehicle speeds	Average speed	Detector station (radar detector/loops/road tubes)
Quantify change in travel time when DMS are used	Network travel time (minutes)	Travel time runs with probe vehicles
Determine if system meets requirements	Performance test results	System test data
Quantify system costs (including equipment and labor)	Procurement cost	Procurement list
	Deployment cost	Bid documents
	Operations cost	Survey/logs
	Maintenance cost	Survey/logs

### Qualitative Evaluation Criteria

MOE	Data Source
Reliability	Survey/logs
Maintainability	Survey/logs
Ease of use	Survey/interview
Owner's perception of value/effectiveness	Survey/interview
Customer perception of value/effectiveness	Survey/interview
Institutional issues	Survey/interview
Technical issues	Survey/interview

## 6.2.15

## ITS Implementation Committee

A standing committee of stakeholders will be created to coordinate and advocate ITS in the SIMPCO area. This type of activity is not generally considered for evaluation.

## 7.0 ITS ARCHITECTURE

### 7.1 National ITS Architecture Overview

The National ITS Architecture provides a common structure for the design of intelligent transportation systems. It is not a system design nor is it a design concept. What it does is define the framework around which multiple design approaches can be developed, each one specifically tailored to meet the individual needs of the user, while maintaining the benefits of a common architecture. The architecture defines the functions (e.g., gather traffic information or request a route) that must be performed to implement a given user service, the physical entities or subsystems where these functions reside (e.g., the transit center or the vehicle), the interfaces/information flows between the physical subsystems, and the communication requirements for the information flows (e.g., wireline or wireless). In addition, it identifies and specifies the requirements for the standards needed to support national and regional interoperability, as well as product standards needed to support economy of scale considerations in deployment.

The main goal of the SIMPCO ITS Architecture is to provide a framework for the development of ITS systems in the SIMPCO area that will allow for the integration and interoperability of future systems. The secondary goal of its development is to conform to the National ITS Architecture, developed by the United States Department of Transportation in 1998. This is critical to any architecture project due in part to the Transportation Efficiency Act for the 21st Century (TEA-21) requirement that all ITS projects funded through the Highway Trust Fund is in conformance with the National ITS Architecture and applicable standards. It is the ITS standards that specify how different technologies, products and components interconnect and interoperate among different systems to share information automatically. Since the enactment of TEA-21, FHWA and FTA have developed additional ITS architecture and standards regulations and policies.

Specifically, regional and project architecture development was targeted through the new regulations and policies.

§ Policy 940.9 – Regional Architecture states the following:

- The FHWA rule and FTA policy require that a region that is currently implementing ITS projects must develop a regional ITS architecture to guide their deployment by April 8, 2005.
- Regions without ITS will have to meet this requirement within four years of their first ITS project advancing to final design.
- The National ITS Architecture shall be used as a resource for developing the regional architecture.
- The regional ITS architecture shall be on a scale commensurate with the ITS investment in the region.

§ Policy 940.11 –Project (Architecture) Implementation, states the following:

- The FHWA rule and FTA policy requires that all ITS projects be based on a systems engineering analysis. The analysis should be on a scale commensurate with project scope.
- Only necessary to develop project architecture for major ITS projects advancing to final design prior to completion of the regional ITS architecture. The project architecture shall contain:
  1. A description of the scope of the ITS project;
  2. An operational concept that identifies the roles and responsibilities of participating agencies and stakeholders in the operation and implementation of the ITS project;
  3. Functional requirements of the ITS project;
  4. Interface requirements and informational exchanges between the ITS project and other planned and existing systems and subsystems; and
  5. Identification of applicable ITS standards.
- Use of adopted USDOT ITS standards in projects.

The two main components of the National ITS Architecture are the Logical and Physical Architecture. The Logical Architecture presents a functional view of the ITS user services<sup>1</sup>. While the Physical Architecture partitions the functions defined by the Logical Architecture into systems, and at a lower level, subsystems, based on the functional similarity of the process specifications and the location where the functions are being performed.

The Logical Architecture defines the functions or process specifications<sup>2</sup> that are required to perform ITS user services and the information or data flows<sup>3</sup> that need to be exchanged between these functions. The functional decomposition process begins by defining those elements that are inside the architecture, and those that are not. For example, travelers are external to the architecture, but the equipment that they use to obtain information is inside. In other words, the architecture defines the functions ITS must perform in support of a traveler's requirements, not the functions of the traveler.

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<sup>1</sup> User services document what ITS should do from the user's perspective. 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.

<sup>2</sup> The textual definition of the most detailed processes identified in the Logical Architecture. The specification includes an overview, a set of functional requirements, and a complete set of inputs and outputs.

<sup>3</sup> Information that is transferred between processes or between a process and a terminator in the Logical Architecture. Data flows are aggregated together to form higher-level Architecture Flows in the Physical Architecture.

ITS functions are depicted using data flow diagrams (see Figure 23 Simplified Top Level Data Flow Diagram). In a data flow diagram, circles represent functions that are broken down into lower levels of detail on subsequent diagrams. The lowest level of decomposition is a Process Specification, e.g., Detect Roadside Pollution Levels. This process detects pollution levels present in the environment and passes the pollution measurement data on to another process, Process Pollution Data, where it is combined with other such detected data.

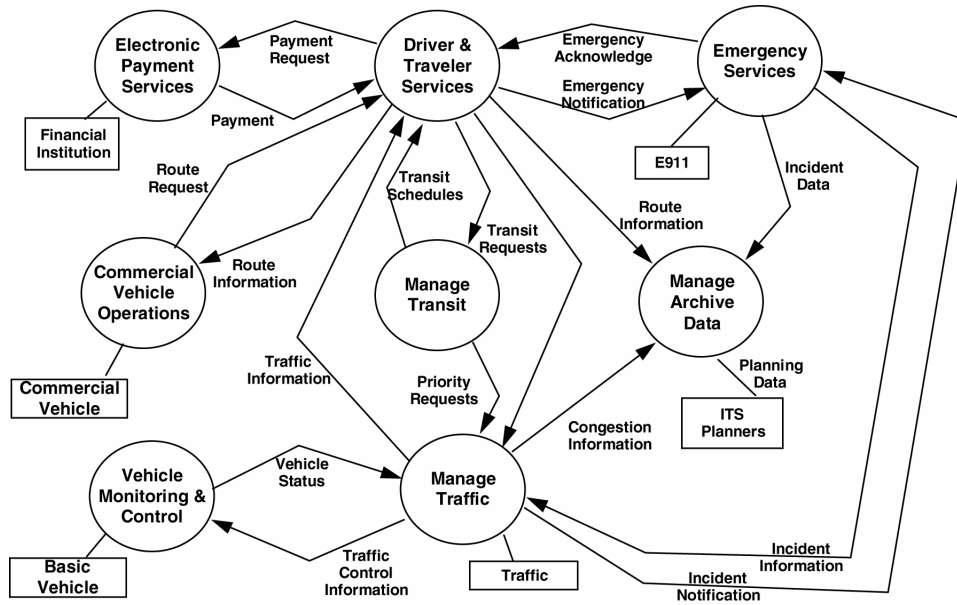


Figure 23 – Simplified Top Level Data Flow Diagram

The Logical Architecture is detail oriented and highly customizable to provide the information necessary for the implementation and deployment of specific project(s).

### Physical Architecture

The Physical Architecture partitions the functions defined by the Logical Architecture into systems, and at a lower level, subsystems, based on the functional similarity of the process specifications and the location where the functions are being performed.

The Physical Architecture provides agencies with a physical representation (though not a detailed design) of the important ITS interfaces and major system components. The Physical Architecture identifies the physical subsystems and architecture flows between subsystems that will implement the processes and support the data flows of the ITS Logical Architecture. The physical architecture defines four systems (Traveler, Center, Roadside, and Vehicle) and nineteen subsystems. The specific choice of nineteen subsystems represents a lower level of partitioning of functions that is intended to capture all anticipated subsystem boundaries for the present, and 20 years into the future.

Example subsystems are the Traffic Management Subsystem, the Vehicle Subsystem, the Roadway Subsystem, and the Remote Traveler Support Subsystem. These correspond to existing (or future) things in the physical world; respectively, traffic operations centers, automobiles, roadside signal controllers, and informational kiosks. A top-level diagram of the physical architecture is shown below.

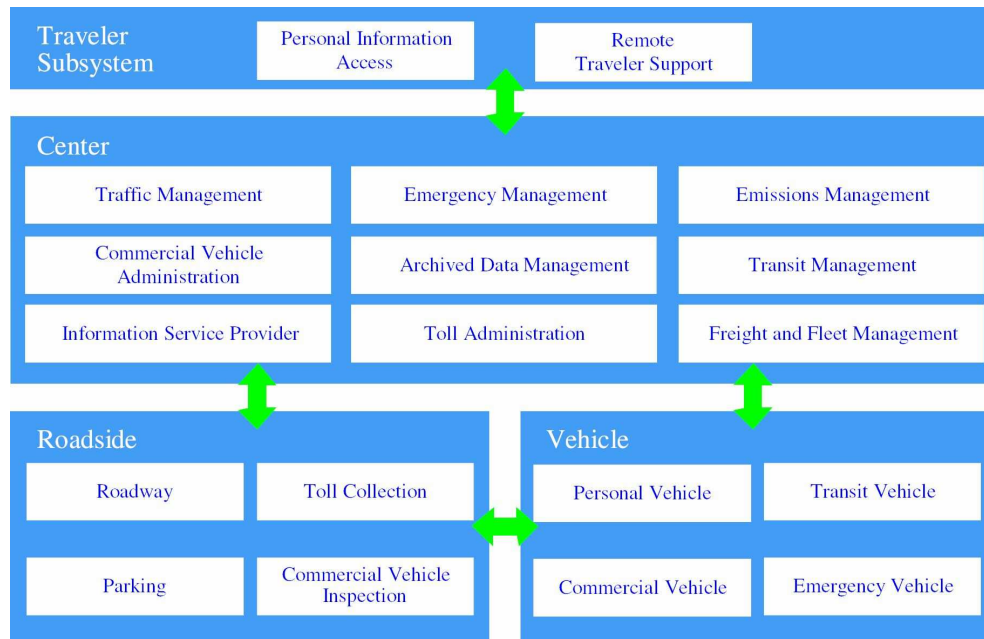


Figure 24 – System and Subsystem Interconnect Diagram

§ **Subsystems** - These perform transportation functions (e.g., collect data from the roadside, provide information to the public, perform route planning, etc.). Processes that are likely to be collected together under one physical agency, jurisdiction, or physical unit are grouped together into a subsystem. This grouping is done to optimize the overall expected performance of the resulting ITS deployments taking into consideration anticipated communication technologies, performance, risk, deployment, etc. A significant level of detail is available for each of these subsystems and their interfaces.

- **Center Subsystems** - provide management, administration, and support functions for the transportation system. The center subsystems each communicate with other centers to enable coordination between modes and across jurisdictions within a region. The center subsystems also communicate with roadside, vehicle subsystems, and traveler subsystems to gather information and provide information and control that is coordinated by the center subsystems. The center subsystems are not physical “brick and mortar” facilities.
- *Commercial Vehicle Administration* - Sells credentials and administers taxes, keeps records of safety and credential check data, and participates in information

exchange with other commercial vehicle administration subsystems and CVO Information Requesters.

- *Fleet and Freight Management* - Monitors and coordinates vehicle fleets including coordination with inter-modal freight depots or shippers.
- *Toll Administration* - Provides general payment administration capabilities to support electronic assessment of tolls and other transportation usage fees.
- *Transit Management* - Collects operational data from transit vehicles and performs strategic and tactical planning for drivers and vehicles.
- *Emergency Management* - Coordinates response to incidents, including those involving hazardous materials (HAZMAT).
- *Emissions Management* - Collects and processes pollution data and provides demand management input to Traffic Management.
- *Archived Data Management* - Collects, archives, manages, and distributes data generated from ITS sources for use in transportation administration, policy evaluation, safety, planning, performance monitoring, program assessment, operations, and research applications
- *Traffic Management* - Processes traffic data and provides basic traffic and incident management services through the Roadside and other subsystems. The Traffic Management Subsystem may share traffic data with Information Service Providers. Different equipment packages provide a focus on surface streets or highways (freeways and interstates) or both. It also coordinates transit signal priority and emergency vehicle signal preemption.
- *Information Service Provider* - This subsystem may be deployed alone (to generally serve drivers and/or travelers) or be combined with Transit Management (to specifically benefit transit travelers), Traffic Management (to specifically benefit drivers and their passengers), Emergency Management (for emergency vehicle routing), Parking Management (for brokering parking reservations), and/or Commercial Vehicle Administration (for commercial vehicle routing) deployments. ISPs can collect and process transportation data from the aforementioned centers, and broadcast general information products (e.g., link times), or deliver personalized information products (e.g., personalized or optimized routing) in response to individual information requests. Because the ISP may know where certain vehicles are, it may use them as “probes” to help determine highway conditions, levels of congestion, and aid in the determination of travel or link times. This probe data may be shared with the Traffic Management Subsystem. The ISP is a key element of pre-trip travel information, infrastructure based route guidance, brokering demand-responsive transit and ridematching, and other traveler information services.
- Roadside Subsystems - These infrastructure subsystems provide the direct interface to the roadway network, vehicles traveling on the roadway network, and travelers in

transit. Each of the roadway subsystems includes functions that require distribution to the roadside to support direct surveillance, information provision, and control plan execution. All roadside subsystems interface to one or more of the center subsystems that govern overall operation of the roadside subsystems. The roadside subsystems also generally include direct user interfaces to drivers and transit users and short-range interfaces to the Vehicle Subsystems to support operations.

- *Roadway* - Provides traffic management surveillance, signals, and signage for traveler information. This subsystem also includes the devices at roadway intersections and multi-modal intersections to control traffic.
- *Toll Collection* - Interacts with vehicle toll tags to collect tolls and identify violators.
- *Parking Management* - Collects parking fees and manages parking lot occupancy/availability.
- *Commercial Vehicle Check* - Collects credential and safety data from vehicle tags, determines conformance to requirements, posts results to the driver (and in some safety exception cases, the carrier), and records the results for the Commercial Vehicle Administration Subsystem.
- Vehicle Subsystems - These subsystems are all vehicle-based and share many general driver information, vehicle navigation, and advanced safety systems functions. The vehicle subsystems communicate with the roadside subsystems and center subsystems for provision of information to the driver. The Personal Vehicle Subsystem includes general traveler information and vehicle safety functions that are also applicable to the three fleet vehicle subsystems (Commercial Vehicle Subsystem, Emergency Vehicle Subsystem, and Transit Vehicle Subsystem). The fleet vehicle subsystems all include vehicle location and two-way communications functions that support efficient fleet operations. Each of the three fleet vehicle subsystems also includes functions that support their specific service area.
  - *Vehicle* - Functions that may be common across all vehicle types are located here (e.g., navigation, tolls, etc.) so that specific vehicle deployments may include aggregations of this subsystem with one of the other three specialized vehicle subsystems types. The Vehicle Subsystem includes the user services of the Advanced Vehicle Control and Safety Systems user services bundle.
  - *Transit Vehicle* - Provides operational data to the Transit Management Center, receives transit network status, provides en-route traveler information to travelers, and provides passenger and driver security functions.
  - *Commercial Vehicle* - Stores safety data, identification numbers (driver, vehicle, and carrier), last check event data, and supports in-vehicle signage for driver pass/pull-in messages.
  - *Emergency Vehicle* - Provides vehicle and incident status to the Emergency Management Subsystem.



- Traveler Subsystems – Traveler Subsystems include the equipment that is **typically** owned and operated by the traveler. Though this equipment is often general purpose in nature and used for a variety of tasks, this equipment is specifically used for gaining access to traveler information within the scope of the ITS architecture. These subsystems interface to the information provider (one of the center subsystems, most commonly the Information Service Provider Subsystem) to access the traveler information. A range of service options and levels of equipment sophistication are considered and supported. Specific equipment included in this subsystem class include personal computers, telephones, personal digital assistants (PDAs), televisions, and any other communications-capable consumer products that can be used to supply information to the traveler.
  - *Remote Traveler Support* - Provides traveler information at public kiosks. This subsystem includes traveler security functions.
  - *Personal Information Access* - Provides traveler information and supports emergency requests for travelers using personal computers/telecommunication equipment at the home, office, or while on travel.

The Physical Architecture has a distinct graphical hierarchy that provides a layered effect to the level of detail. A diagram which depicts the nineteen subsystems for full representation of ITS and the basic communication channels between these subsystems is the “Sausage Diagram”. The “Sausage Diagram” is a top-level subsystem interconnect diagram, in which the communication links are the “sausages”. This diagram graphically displays the nineteen subsystems, which are grouped into the aforementioned categories based on their function and location, and the communications media interfaces (see Figure 25 for the generic “Sausage Diagram” provided by the National ITS Architecture).

As seen in the figure to follow the National ITS Architecture identifies four communications media types to support the communications requirements between subsystems. They are wireline (fixed-to-fixed), wide area wireless (fixed-to-mobile), dedicated short-range (fixed-to-mobile) and vehicle-to-vehicle communications (mobile-to-mobile).

Another element of note within the Physical Architecture is the terminator. There are 60 terminators that define the boundary of the National ITS Architecture. The terminators represent the people, systems, and general environment that interface to ITS. The interfaces between terminators and the subsystems and processes within the National ITS Architecture are defined, but no functional requirements are allocated to terminators. It should be noted that architecture has no interconnections between terminators, only subsystems. The 60 terminators are bundled into four types:

- Environment – 7 terminators (environment, traffic, etc.)
- Humans – 19 terminators (driver, transit user, etc.)
- Systems – 26 terminators (event promoters, financial institution, etc.)
- Other Systems – 8 terminators (other vehicle, other emergency management, etc.)

One step down from the top-level architecture interconnect diagram (“Sausage Diagram”) is a high-level interconnect diagram. The high-level interconnect diagram depicts the subsystem (and terminator) interactions. The level of detail here is slightly finer than the “Sausage Diagram”; here one can see the exact interconnects between the various subsystems. Figure 26 displays an example interconnect diagram.

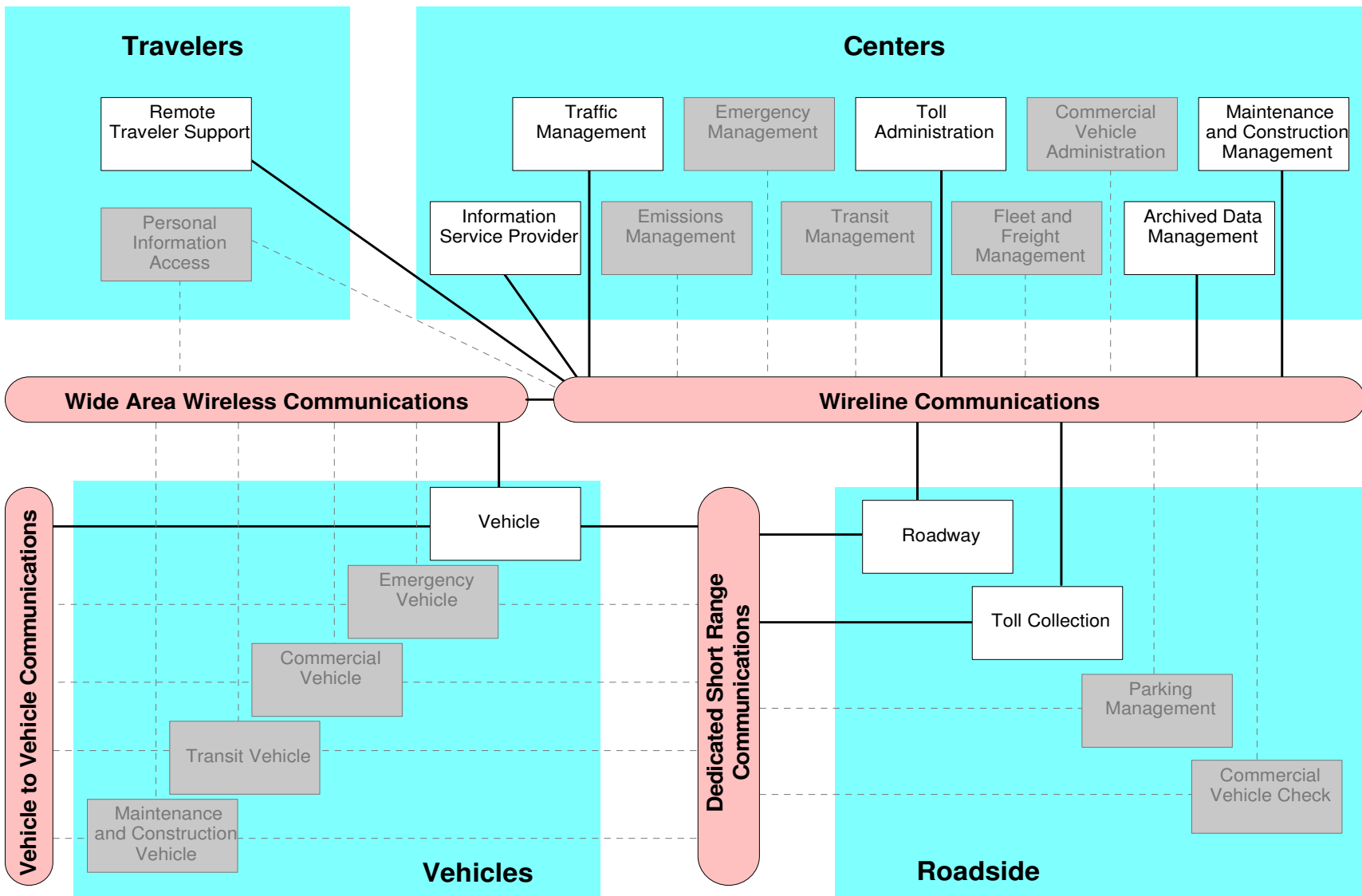


Figure 25 – Generic National ITS Architecture “Sausage Diagram”

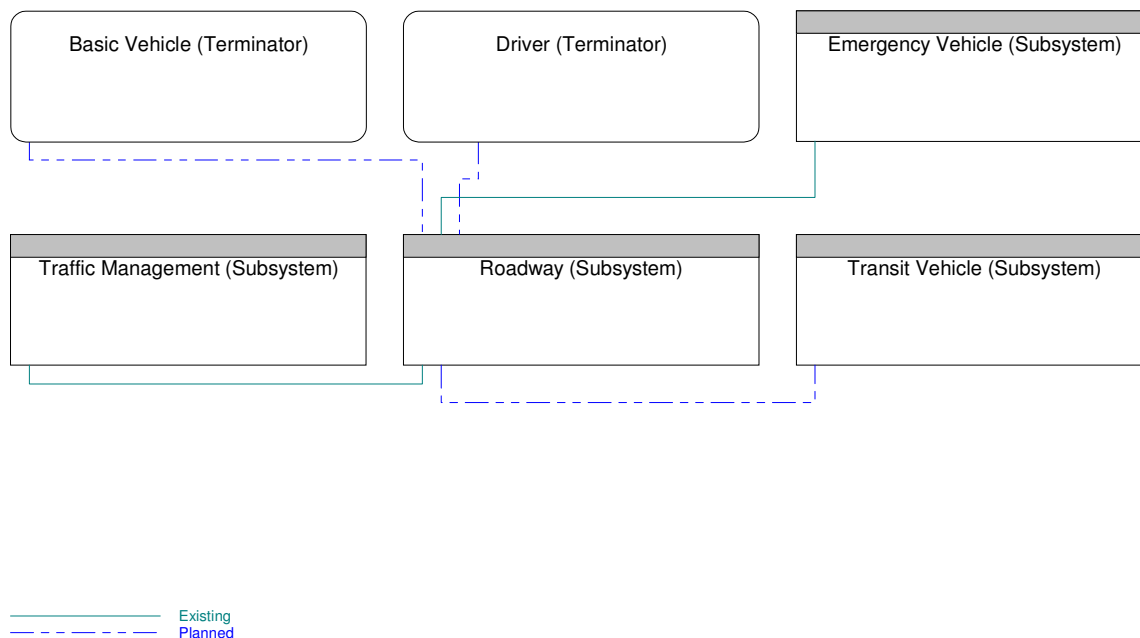


Figure 26 – Example High-Level Interconnect Diagram (Roadway Subsystem)

This type of architecture detail lends itself to the overall system design process. The interconnections in this type of diagram tell the story of which subsystems communicate with one another and the environmental, human, and/or other type of system interaction that may be involved.

Another layer of detail is yet available for architecture depiction, the subsystem architecture flow diagram. This type of diagram depicts the subsystem to subsystem/terminator interaction or information sharing via architecture flows<sup>4</sup>. Architecture flows are a derivative of market packages<sup>5</sup>. Figure 27 displays an example Subsystem Architecture Flow Diagram.

<sup>4</sup> Information that is exchanged between subsystems and terminators in the Physical Architecture. Each architecture flow contains one or more data flows from the Logical Architecture. These architecture flows and their communication requirements define the interfaces which form the basis for much of the ongoing standards work in the ITS program.

<sup>5</sup> The market packages provide an accessible, deployment oriented perspective to the national architecture. They are tailored to fit - separately or in combination - real world transportation problems and needs. Market packages collect together one or more Equipment Packages that must work together to deliver a given transportation service and the Architecture Flows that connect them and other important external systems. In other words, they identify the pieces of the Physical Architecture that are required to implement a particular transportation service.

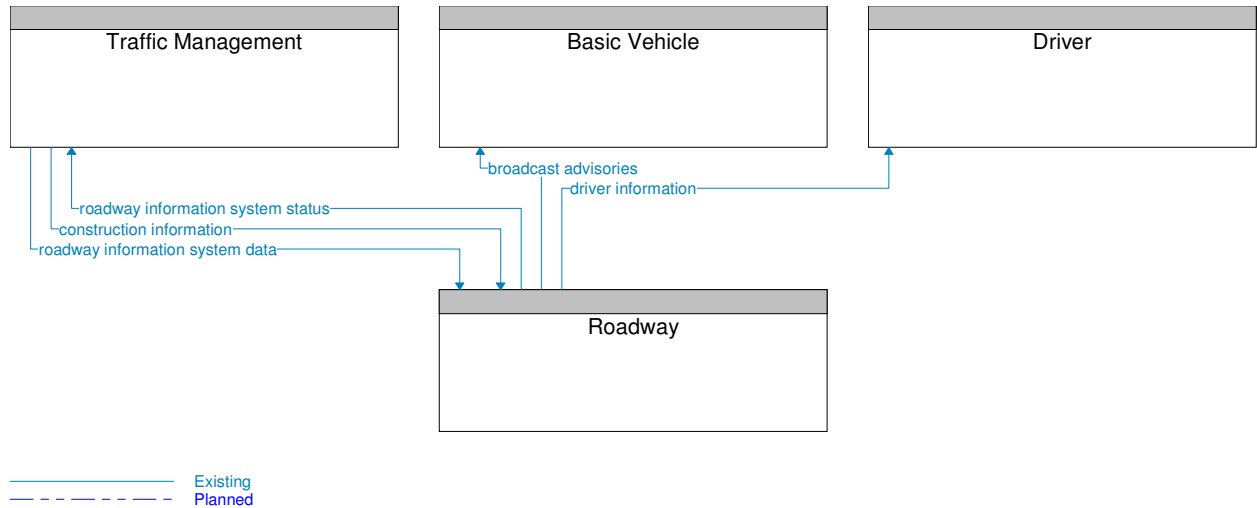


Figure 27 – Example Subsystem Architecture Flow Diagram

## 7.2 SIMPCO ITS Architecture

In accordance with the Federal Highway Administration’s mandates on ITS projects implemented after April 8, 2001, SRF Consulting Group, Inc. incorporated the Architecture development process directly into the ITS planning process for the SIMPCO area ITS Plan. The SIMPCO ITS Architecture was designed from the “physical” perspective. As previously stated, the Physical Architecture provides agencies with a physical representation (though not a detailed design) of the important ITS interfaces and major system components.

### 940.9 Regional ITS Architecture Requirements

Requirement	Status
Develop a Regional Architecture including:	
§ A description of the region	Complete
§ Identification of participating agencies and other stakeholders	Complete
§ An operational concept that identifies the roles and responsibilities of participating agencies and stakeholders in the operation and implementation of the systems included in the regional ITS architecture	Complete (via Iteris/HR Green Study; May 2004)

§ Any agreements (existing or new) required for operations, including at a minimum those affecting ITS project interoperability, utilization of ITS related standards, and the operation of the projects identified in the regional ITS architecture	Complete (SIMPCO ITS committee and Architecture maintenance)
§ System functional requirements	Complete ( Sections 3.0/4.0)
§ Interface Requirements and information exchanges with planned and existing systems and subsystems (for example, subsystems and architecture flows as defined in the National ITS Architecture)	Complete (Section 4.0)
§ Identification of ITS standards supporting regional and national interoperability	Complete (Appendix B)
§ The sequence of projects required for implementation	Complete (Section 5.0)
§ Develop and implement procedures and responsibilities for maintaining it, as needs evolve within the region	Complete

The Architecture was developed by tailoring the National ITS Architecture as appropriate to meet the needs of the region. User needs were collected from various stakeholders throughout the plan development process. Involvement from the following sources was used to identify user needs:

- City of Sioux City
- City of South Sioux City
- City of North Sioux City
- City of Sergeant Bluff
- Nebraska DOR
- FHWA – Iowa and South Dakota Divisions
- Woodbury County EMS
- Woodbury County Sec. Roads
- SIMPCO

- Iowa DOT
- South Dakota DOT
- Union County
- Dakota County
- Siouxland Regional Transit System

The user needs along with the existing ITS systems throughout the region serve as the stimulus for architecture development. The user needs were mapped to the National ITS Architecture user services and subsequently the market packages. The following section discusses this process in further detail.

Benefits that will be realized by tailoring the National ITS Architecture into the regional SIMPCO ITS Architecture are:

- § Interoperability – The National ITS Architecture has identified where standards are needed for system interoperability (interfaces and products). Because the Nation ITS Architecture serves as the common foundation of ongoing ITS standards development work, factoring it into the current system enhancement will facilitate the transition to a standard interface definition in the future. Using standard interfaces will provide for national and regional interoperability and interchangeability of systems and devices used in ITS management.
- § System Expandability – Use of the common structure defined across the area in conjunction with use of open standards will make it easier to integrate the existing systems with new ITS components and systems.
- § Increased Competition – Use of open standards for system interfaces will allow multiple vendors to bid on projects, resulting in greater competition and lower bid prices.
- § Increased System Integration – Use of the architecture will make integration of the jurisdictional system easier, resulting in increased information sharing. Travelers moving through the area will ultimately benefit from this seamless system.
- § To illustrate how the regional SIMPCO ITS Architecture can be applied on specific ITS projects, a complete list of proposed ITS projects will be included in the ITS Plan. The projects descriptions are complete with full system operational concepts and implementation possibilities. The regional Architecture will capture each of these ITS projects, and incorporates them into the entire picture with the existing systems that are in place and the proposed/future components on a statewide level.

### ***Architecture Development Process***

- § The SIMPCO Architecture was developed in a two-step process:
- § Step one used an inventory of existing system to create a “baseline” architecture.

- § Step two incorporated the results of issues identification efforts mapped to User Services and Market Packages in the Architecture to create additional “Planned” flows and elements.

Having the user needs (issues) for the region allows one to gain access into the National ITS Architecture and begin the development process for a regional specific architecture. The user needs can be cross-referenced (or mapped) to a component of the National ITS Architecture called “user services.” User services document what ITS should do from the user's perspective. They encompass a broad range of users, including the traveling public as well as many different types of system operators. User services form the basis for the National ITS Architecture development effort. 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. This user need to user service mapping begins the architecture sculpting process (see Table 6).

The end result of the architecture development process is to identify and display the framework for system operation in and throughout the Rapid City area. Because of the National ITS Architecture's layout all of its components are traceable to one another. To obtain the end result mentioned the user services are then mapped to market packages from the National ITS Architecture. Again, the market packages provide an accessible, service-oriented perspective to the National ITS Architecture. They are tailored to fit, separately or in combination, real world transportation problems and needs. Market packages collect together one or more equipment packages that must work together to deliver a given transportation service and the architecture flows that connect them and other important external systems. In other words, they identify the pieces of the physical architecture that are required to implement a particular transportation service. Table 7 displays the user service vs. market package mapping.

Several factors influenced the development of this architecture. Specifically the previous architecture work done by the State of South Dakota and the City of South Sioux City provided some guidance in creating the naming conventions. Wherever appropriate, similar names and structures were used for SIMPCO.

As ITS efforts in the MPO continue to evolve, this architecture will need to be revised and managed, as it provides a “snapshot” of a moment in time for ITS deployments. The terminology and extent of the National ITS Architecture will change over time as will the systems and subsystems in use in the Siouxland area. For those reasons, it is important that the ITS Architecture have a “steward” to maintain and keep it current.



**Table 6 User Needs to User Services**

Issues	Category	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	2.1 Public Transportation Management	2.2 En-route Transit Information	2.3 Personalized Public Transit	2.4 Public Travel Security	3.1 Electronic Payment Services	4.1 Commercial Vehicle Electronic Clearance	4.2 Automated Roadside Safety Inspection	4.3 On-board Safety and Security Monitoring	4.4 Commercial Vehicle Administrative Processes	4.5 Hazardous Material Security and Incidence Response	4.6 Freight Mobility	5.1 Emergency Notification and Personal Security	5.2 Emergency Vehicle Management	5.3 Disaster Response and Evacuation	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	7.1 Archived Data Function	8.1 Maintenance and Construction Operations		
Improve coordination for maintenance and deployment of regional information technology infrastructure	Efficiency																																			
Improve 511 system interoperability	Satisfaction																																			
Decrease cost to users for 511 service/expand service availability	Satisfaction																																			
Improve ability of emergency response agencies to coordinate actions and communicate information	Efficiency							ⓧ															ⓧ	ⓧ												
Improve ability for area signal systems to be administered/managed	Efficiency						ⓧ																													
Improve functionality of area signal systems	Efficiency						ⓧ																													ⓧ
Decrease response times for emergency responders	Efficiency						ⓧ																	ⓧ												
Improve temporary traffic management capabilities	Efficiency						ⓧ	ⓧ																												
Reduce roadway icing impacts	Safety																																			ⓧ
Better manage the traffic impacts of at-grade RR crossings	Mobility						ⓧ				ⓧ																									
Improve information collection and distribution for construction events	Satisfaction	ⓧ				ⓧ	ⓧ																													ⓧ
Improve the dissemination of traveler information	Satisfaction	ⓧ				ⓧ																														
Decrease the incidence of red-light violations	Safety						ⓧ																													
Improve automated traffic counting/vehicle classification data	Efficiency						ⓧ																													
Improve data operational/condition data sharing between jurisdictions	Efficiency																																			ⓧ
Oversized truck loads striking freeway overpasses	Safety																	ⓧ	ⓧ																	



The architecture flow outputs, obtained from the market package association, are tailored to fit the ITS applications that are existing or planned for deployment. This tailoring of the architecture gives it its own identity. The architecture flows together with the subsystems that they connect create the visual framework of the architecture, called architecture diagrams. There are different levels of architecture diagrams, top-level interconnect (“Sausage Diagram”), high-level interconnect and subsystem architecture flow diagrams.

There are 61 different elements (both subsystems and terminators) associated with the SIMPCO Architecture. For clarity and organization the diagrams that are displayed here were put into categories of elements. The categories are comprised of the following:

- Archive Elements – The archive elements view consists of all of the subsystems that provide an archive data function. This diagram includes those subsystems that interact with the archive data elements.
- County Elements – All County associated subsystems (i.e., County sheriff, construction and maintenance, etc.).
- Emergency Elements – Grouped all elements that are associated with the emergency services function in the region. This would include State highway patrol, County fire services and ESCC.
- Private Elements – Private providers of a service or connection within the architecture (cable access television or private travelers’ personal access equipment).
- Roadway Elements – All roadway field deployments and their associated subsystems.
- State Office Elements – All subsystems related to Nebraska, South Dakota or Iowa.
- Weather Elements – Subsystems that have a weather related function, including inputs to the weather related subsystems.
- Transit Elements – All elements related to public transit systems and their related subsystems.

It should be noted that with each grouped diagram there may an interconnection that is not seen given the category. The physical architecture view of the regional Architecture provides SIMPCO with a high-level view of its ITS system improvements. Once projects are approved and the system design process is begun, the Architecture will assist in determining what components should interface with one another and what they should accomplish. It will allow for multiple design approaches to be developed increasing the possibilities for system success. The graphical representations of the regional SIMPCO ITS Architecture are shown in Appendix A: Architecture Diagrams.

Each of the information flows in the Architecture documentation has associated with it one or more standards defining the nature, content and methods of transmission. At this point a number of standards are in the proposed stage and will not be finalized for some time. Other standards (such as those for DMS) are fully developed and their implementation may be required for eligibility for certain funding sources. As the status of these standards is evolving, it is recommended that they be reviewed in the pre-design stage of any project to assess the implications for component selection. A complete listing of relevant standards as of March 2005 is shown in Appendix B: ITS Architecture Standards.